THE SECRETORY AND THE EXCITO-SECRETORY SYSTEM.

BY

H. F. CAMPBELL.

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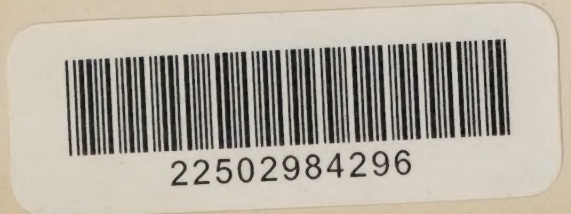

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ESSAYS

ON THE

SECRETORY AND THE EXCITO-SECRETORY SYSTEM OF NERVES

IN THEIR RELATIONS TO

PHYSIOLOGY AND PATHOLOGY.

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COMPRISING

I. A NEW CLASSIFICATION OF FEBRILE DISEASES.

II. AN EXPOSITION OF THE "GANGLIONIC PATHOLOGY" OF ALL CONTINUED FEVERS, AS ILLUSTRATED IN TYPHUS AND TYPHOID FEVER.

III. THE PRIZE ESSAY ON THE EXCITO-SECRETORY SYSTEM OF NERVES IN ITS RELATIONS TO PHYSIOLOGY AND PATHOLOGY.

IV. A LETTER TO DR. MARSHALL HALL, OF LONDON, CLAIMING PRIORITY IN THE DISCOVERY AND NAMING OF THE EXCITO-SECRETORY SYSTEM OF NERVES.

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7135

BY

HENRY FRASER CAMPBELL, A.M., M.D.,

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WITH ILLUSTRATIONS.

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TO

MARSHALL HALL, M.D., F.R.S.,

MEMBER OF THE INSTITUTE OF FRANCE,

AND

AUTHOR OF THAT GRAND INDUCTION OF MODERN PHYSIOLOGY, "THE PRINCIPLE OF REFLEX NERVOUS ACTION,"

This Collection of Essays

ON

THE SECRETORY AND THE EXCITO-SECRETORY SYSTEM,

IS RESPECTFULLY INSCRIBED,

IN HIGH ADMIRATION OF HIS GENIUS,

AND IN

HEARTFELT ACKNOWLEDGMENT OF HIS LIBERALITY,

BY

THE AUTHOR.

PREFACE.

THE several papers composing the following little volume were on different occasions presented as *reports* to the American Medical Association, and, with the exception of the Letter to Dr. Marshall Hall, will be found published in the Transactions of that body. They have, at least most of them, been distributed privately to various distinguished members of the profession in *pamphlet* form. Their scattered condition, as they exist in the volumes of the Transactions, and the proverbially perishable nature of pamphlet literature, have induced us to bring in the close relation of a single volume, our several papers on the Nervous System, which appear to us to have a special relation to one another, in order that we may gain for our views before the reader that advantage which will accrue from a simple juxtaposition and an uninterrupted reading.

One of the most distinguished essayists[1] of modern times has remarked, that "the rarest works are frequently the most original; for precisely in proportion as an author is in advance of his age, is it likely that his works will be neglected; and the neglect of contemporaries, in general, consigns a book, especially a small book, if not protected by accidental concomitants, at once to the tobacconist or tallow-chandler. This is more particularly the case with *pamphlets*." The same writer here instances the neglect sustained by the philosophical pamphlet of Arthur Collier, which, though long antecedent and far more original than the large volume of Bishop Berkeley, yet sank into oblivion, because it was a pamphlet and

[1] Sir William Hamilton.

not a volume. It is to save *our pamphlet* on "Typhoidal Fevers," which we humbly hope contains at least the *germ* of the truth in regard to the pathology of this class of fevers, from the fate of passing into the department of "Forgotten Literature," that we now make it a part of a *system*, which admits of a board-bound volume for its elaboration.

The *Letter to Dr. Marshall Hall*, contains all of our earlier publications on the excito-secretory system, and we have therefore withheld the separate introduction of those papers in the present volume. This letter will be found also to contain the previous claim of priority made before the American Medical Association, on the announcement of Mons. C. Bernard in 1853. At the time of its publication, one or two of our friends said, that we but expressed views which they themselves had entertained in an indefinite form for years. Mr. Carlyle gives utterance to an idea which fully explains this general recognition of original views as things not altogether unfamiliar. It is something like this: that at a time immediately preceding *every* discovery in science or art, there are vague, detached, *elementary portions* of it floating through the brains of many, who, having only *parts* of the truth, but *partly* express it, or do not express it at all, or are not sufficiently *convinced* of the truth to proclaim it boldly,[1] but still it has become somewhat

[1] "That man is not the discoverer of any art who first says the thing; but he who says it so long, and so loud, and so clearly, that he compels mankind to hear him—the man who is so deeply impressed with the importance of the discovery that he will take no denial, but, at the risk of fortune and fame, pushes through all opposition, and is determined that what he thinks he has discovered shall not perish for want of a fair trial."—See *Tyler Smith on Parturition.*

The following, which comes to us while these pages are undergoing correction, is found in an obituary notice of Dr. Marshall Hall, and the very diction indicates who the author is. Here is the penetrating insight of the Philosopher yoked with the sprightly gleaming of the Poet. It is from the glowing pen of Dr. Oliver Wendell Holmes. In referring to Dr. Hall's discovery of Reflex action—Excito-*motory* action, and the disputations following its announcement by him, this writer uses the following striking language:—

"Others may have more or less perfectly observed and announced some of the facts in the series of demonstrations. But they spoke in a whisper or in a corner,

familiar to many, so that when he who is justly entitled to be called the originator of the system *announces* it, "What *he* says," to use the author's own language, "*all* men were not far from saying—indeed, were *longing* to say. The thoughts of all start up, as from painful, enchanted sleep, round *his* thought, answering to it, 'Yes, even so!' We all feel as if we could, and some feel as if we did, fashion such a result. The *built* house seems all so fit, every way as it should be—as if it came there by its own law and the nature of things—that we forget the rude, disorderly quarry it was shaped from. The very perfection of the house, as if nature herself had made it, hides the builder's merit." We claim no great perfection for our work, nor merit for ourself, except the merit of originality already fully accorded us. We know that "the excito-secretory system will," as Dr. Marshall Hall says, "require many laborers and many years for its perfection." We claim no other merit, because it was to an incident of our early youth[1] that we owe the direction given to our mind which led to the result, however important it may have since proved and may yet prove. It is far from being, as yet, a "*built* house," but we claim to have, at least, been the first who fitted the materials and showed how they were to be put together.

The CLASSIFICATION of *febrile diseases* found in the introduction to this volume, we sincerely believe to be the *true* one, and with truth for its basis, we do not hesitate to predict that, in time, it must become the *accepted* one.

We will make one remark about the prize essay near the end of this collection, and then close our rather lengthy preface. It will

and when they had once spoken, were quiet. He cried his doctrine and its proofs aloud in the street and in the academy; he shouted it over and over again, until he was hoarse with calling; he printed it in little pamphlets and big books; he dressed it in Italics and capitals, as if it were an incendiary proclamation; he wearied the very echoes with it, until at last the deaf and surly world took up its ear-trumpet and listened—and lo! one of the startling truths that make a century luminous in the procession of time, and lift a withered student into planetary reputation!"—*Boston Med. and Surg. Journal.*

[1] See note, p. 130.

doubtless appear to some readers, that we have given the *motto* of the essay too much prominence in the discussion; where such is the opinion, we can only express our regret that we feel obliged to differ. The motto of this essay was intended by us, rather as a principal theme for discussion, equal in importance with the professed subject itself, than as, simply a motto; hence it will be found that a large portion of the paper, while it does not overlook the development of the excito-secretory system, is yet earnestly devoted to illustrating the fallacy of *experiment* when not properly governed by correct *observation* and reasoning; while, on the other hand, we have endeavored to illustrate the great value of many observations where no *experiment*, in the technical sense, has been made, claiming for the observation at least equal value with the experiment when applied to the purposes of induction. "Observation is a lens which collects the distant rays of the past into a focus upon the present, that it may consume the *false* or kindle into higher life the *true*."[1]

These remarks have been thus far prolonged, from the desire, on our part, to give to these essays, written on different subjects and at long intervals, that "oneness" which, in our opinion, a *volume* should ever present. And notwithstanding all our care, we feel constrained, in conclusion, to use the apt language of another,[2] "we are sensible that we have not disposed our materials to abide the test of captious controversy, but of a sober and even forgiving examination; that they are not armed at all points for battle, but dressed to visit those who are willing to give a peaceful entrance to truth."

Augusta, Ga., *July*, 1857.

[1] Bidwell's Eclectic Magazine.

[2] Edmund Burke. On the Sublime and Beautiful.

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I.

THE NERVOUS SYSTEM

IN

FEBRILE DISEASES.

INTRODUCTION TO ESSAY ON TYPHOIDAL FEVERS.

THE CLASSIFICATION OF FEBRILE DISEASES BY THEIR RELATION TO THE NERVOUS SYSTEM.[1]

During the examination of our subject since the time of our appointment as a special committee, by this Association, we have been, at each step, more and more impressed with its importance, and at the same time with the extreme difficulty attending its full, clear, and thorough elaboration. "A man," says Lord Bacon, "must collect facts, in order to know the *law* of facts;" diligently and earnestly engaged for the year past, in collecting and interrogating the facts which have a bearing on the important subject of Febrile Diseases, in the relation assigned us for examination, we have scarcely had time to do more than *note*, here and there, the gleam of truth which has been evolved during a bare hasty collocation of data; much less to determine satisfactorily any fixed law in relation to the vast subjects involved in the investigation. That such laws will be recognized, and that the careful generalization of the facts will be productive of important, fruitful results, we have already seen enough fully to persuade us. Pleading then the magnitude, as well as the embarrassments of the subject, we ask of this Association the privilege of having our special committee continued for another year, allowing us at present to lay before this body a few conclusions arrived at, as the result of the investigation in its present state of progress.

I. As all the normal phenomena of the living organism are known to occur under the superintending influence of the nervous system, and are dominated by it, so it is but rational to regard all morbid actions as being more or less influenced in their manifesta-

[1] See "Partial Report on the Nervous System in Febrile Diseases." Trans. Amer. Med. Association, Vol. X.

tions by *aberrated* nervous action. In that class of diseases ordinarily designated fevers, our researches and observations have led us to the confident belief that the above law applies with sufficient prominence to constitute the basis of their classification, and we would here respectfully claim for it, that it is the only *reliable* basis of their classification, and further, that in its more extended application, it will hereafter be found to constitute what may be called par excellence, *the Law of Febrile Diseases.* Simply to assert the recognition of this law, and to suggest a new and more comprehensive classification of Fevers based upon it, is the sole object of the present brief exposition.

II. As in the Nervous System, we recognize two grand departments, viz: 1st. The Cerebro-spinal System, all the normal actions of which are subject to cessations and interruptions; and, 2dly. The Ganglionic System, all the normal actions of which are of a continuous and *un*interrupted character, so in the manifestations of febrile diseases, do we distinctly recognize two grand distinguishing characteristics respectively typifying the *normal* actions of these two systems of nerves: thus, a character of *paroxysm* obtains in certain cases, while a character of *continuousness* as plainly marks the others.

III. Again: as in the Cerebro-spinal System, we find that its normal action pertains almost exclusively to sensation and to motion, with only a secondary and comparatively somewhat remote influence (which we have termed Excito-Secretory) upon nutrition and secretion, while in the normal action of the *Ganglionic* System the entire function is known to be, to preside over nutrition and the secretions; so in *paroxysmal fevers* do we find intense pain, modified sensation, and symptoms allying them to neuralgic and convulsive diseases very prominent, while in *continued fevers*, modified nutrition and altered secretion, are the marked and most prominent characteristics. We would, therefore, *announce* as our classification of febrile diseases, two grand divisions of fevers corresponding with the two grand divisions of the nervous system, thus:—

I. Cerebro-spinal Fevers.

All *Paroxysmal.* The secretions and nutrition only *secondarily* affected.

II. Ganglionic Fevers.

All *Continued.* The secretions and nutrition *primarily* affected.

I. Under the head of CEREBRO-SPINAL FEVERS, we would place the whole family of Paroxysmal Fevers, whatever type they may assume,[1] and, also, the various forms of neuralgia, which are nearly always intermittent, as well as the *sthenic* forms of Traumatic Fever, together with the Fever accompanying simple Pharyngitis, Pneumonitis, Dysentery,[2] and many other diseases of malarial districts.

II. Under the head of GANGLIONIC FEVERS, OR FEVERS OF THE SECRETORY SYSTEM OF NERVES, we think that we find ample ground for bringing together many diseases heretofore widely estranged from each other. Thus, as the archetypal form of ganglionic fevers, we place at the head of the list, typhus and typhoid fever,[3] then, allied to these in various degrees of affinity, but all *equally*, in the one essential element, that *they present themselves as manifestations of disease through the Ganglionic System*, are variola, scarlatina,[4] rubeola, varicella, and many other forms of eruptive fevers, heretofore not classified by nosologists. All of these last diseases are marked by fever of a *continued* or *non-paroxysmal* character, all present marked aberrations of nutrition and secretion, and each has its own peculiar eruptive character; and, further, each one is definitely *self-limited in its duration*, as yet, no remedial interference having been found competent to arrest or shorten their progress.

We will here make the remark, that we do not wish to be mistaken as classifying these diseases in relation to their eruptive fea-

[1] The primitive location of these fevers, in the cerebro-spinal system, was developed by Prof. L. D. Ford, of the Medical College of Georgia, in the *Southern Medical and Surgical Journal*, in 1836, and called by Maillot, "Cerebro-spinal Intermittent Irritations."

[2] See Clinical Lectures at Jackson Street Hospital "On the Pathology and Treatment of Dysentery, by Robert Campbell, M. D., Demonstrator of Anatomy in the Medical College of Georgia." In these Lectures the relation of Dysentery to Paroxysmal Fever is fully considered by my brother.

[3] As first developed in an essay entitled: "*An Inquiry into the Nature of Typhoidal Fevers, based upon a Consideration of their History and Pathology*," presented to the American Medical Association, at its Session of May, 1853, by Henry F. Campbell, Chairman of Committee on Typhoid Fever. The implication of the ganglionic system of nerves, in typhus and typhoid fever, has been, in the above essay, argued *at length*. We would now assert—that Asiatic Cholera and its kindred diseases present a class of symptoms which pre-eminently manifest that the *ultimate location* of these affections is in the *Ganglionic* or *Secretory system of nerves*.

[4] M. Trousseau, in his recent Lectures on Scarlatina, seems to take a similar view. He says: "The ganglionary system is implicated."

ture, but only as signifying a recognition of the common influence of the secretory system of nerves in all of them *by* the eruption. In typhoid fever itself, it must be recollected that the *eruption* is not a prominent feature, and yet, we consider the secretory system of nerves primarily deeply affected, and place this at the head of the list, notwithstanding the fact, that the ganglionic implication manifests itself *but little* upon the skin and mainly in the intestinal canal.[1]

It may be asked, if all of these fevers are due to aberration in the innervation of the ganglionic or secretory system of nerves, why should they present such marked specific differences? A satisfactory answer may be given thus: that specificity of morbific cause must rationally be expected to secure a specificity of morbid manifestation; thus, the virus of variola, when taken into the system, gives rise to the morbid manifestations peculiar to smallpox, while the morbific influence (of whatever nature it may be) of typhoid fever, produces a specific form of disease entirely different, but not the less for that reason, locatable in parts of the organism entirely controlled by the secretory nervous system.

Blending of Types of Fever.—Much interest has been taken by this Association, for the last five years, in the subject of the Blending of the Types of Fever. We would claim, for the present Pathology and Classification of Fevers, that it is the *only* one which admits of any plausible explanation of the mysterious phenomena comprehended under the term, "Blending of Types;" thus, a cerebro-spinal or *paroxysmal* fever may assume, under certain circumstances, some of the characteristics of some one or other of the forms of *continued* fever. This, we hold, can be explained by attributing it to a propagation of the irritation, originally located in the spinal marrow, to the ganglia of the secretory system. Then, again, the reverse may obtain; we may find, and do often find, in *continued* fevers, especially in malarious districts (whether the case be typhoid fever, rubeola, or scarlatina), *intermittent* paroxysms, interrupting the even course of the *continued* form, sometimes obscuring the diagnosis, and making it necessary to modify the treatment. The use of quinine, it is well known, will generally break up these *paroxysms*, but not in the least modify the course of the *continued* fever. In the first of these cases, the morbific influence has been "*centripetal*," and in the second "centrifugal," and

[1] See Inquiry, &c., pp. 53 and 54.

thus the "blending of types" may be rationally and philosophically explained.

We are aware that, in presenting thus a condensed exposition on the obscure subject of "The Nervous System in Febrile Diseases," without more argument and fuller elaboration, we are running the risk of being charged with "bare assertion," but we will honestly avow, that each proposition has been earnestly and carefully considered, keeping constantly in view all the phenomena of febrile diseases—comparing them faithfully with the normal actions of the two grand departments of the nervous system.

It will be remarked, that we have not attempted to define what is the exact morbid condition of the nervous centres, or of the nerves, which gives rise to the phenomena in the two classes of fever. Such a process of reasoning we have carefully abstained from, because such a discussion would be conversant about subjects which cannot as yet be said to have been brought within the legitimate domain of science. We can only as yet trace the effects to their causes; it is a different thing to discuss the nature of the causes themselves; and as Professor Whewell has made a distinction between the *Laws* of Phenomena and the *Causes* of Phenomena, so we only here claim to have recognized a *Law*, leaving the more recondite inquisition into the *Causes*, for a more advanced and enlightened age of science. In conclusion, we will say, we may have been, in the above exposition, unfortunately obscure in presenting to others what has become a clear and well defined conviction to us; but in the pertinent language of another,[1] whose deep philosophy has charmed us, while it has been of unspeakable service to us in many of our investigations, we will say, that "to our mind this doctrine stands firm and impregnable—assailable by no known fact consistent with every established truth."

[1] Dr. M'Cosh, on the Method of the Divine Government.

II.

AN INQUIRY

INTO THE

NATURE OF TYPHOIDAL FEVERS.

AN INQUIRY

INTO THE

NATURE OF TYPHOIDAL FEVERS.

BASED UPON A CONSIDERATION OF

THEIR HISTORY AND PATHOLOGY,

AND ILLUSTRATING

THE GANGLIONIC PATHOLOGY OF ALL CONTINUED FEVERS.

To this confidence I have come, not merely through the convictions of my own consciousness, but from finding in this system, a centre and conciliation for the most opposite of philosophical opinions.—HAMILTON.

PRESENTED TO THE AMERICAN MEDICAL ASSOCIATION,

AT ITS SESSION OF MAY, 1853.

ERRATA IN ESSAY ON TYPHOIDAL FEVERS.

Page 37, line 16, *for* "*and* that," *read* "*or* that."
Page 50, line 32, *for* "opposite," *read* "apposite."
Page 55, line 19, *for* "internal," *read* "intimate."
Page 56, line 14, *for* "*Pathology*," *read* "*pathological Anatomy.*"
Page 58, line 26, *for* "action," *read* "section."
Page 58, line 29, *for* "a normal action," *read* "abnormal action."

AN INQUIRY

INTO THE

NATURE OF TYPHOIDAL FEVERS.

An analysis of the symptoms of typhoid fever, with a view to its correct pathology, is embarrassed by the difficulty which presents itself in the selection of those phenomena and events which are really characteristic of the disease; for in the immense body of recorded observations with which the investigator is presented, there are comparatively but few which belong essentially to typhoid fever. In the following paper, it has been our object to give a brief but careful summary of its most prominent features, illustrating them when necessary by cases from the latest and most approved authorities, from a consideration of which our deductions have been made.

We have in no instance referred to our own observations of cases, for it is obvious to our mind that any views of disease founded mainly upon rational induction, would be less liable to fallacy, when based on the recorded, careful observations of others, than when they are merely the interpretation of our own cases, always liable to preconceived opinions and foregone conclusions, which have ever proved most effectual and deplorable barriers to correct observation. It is true that, in the plan here adopted, the same objection to a great extent will be found to exist; but by this method we are freed from the fallacies which would be apt to arise from a personal record, with a view to establish a doctrine, and will have to contend only with those which must necessarily attach to the interpretation of data, the record of which has in many instances been intended to corroborate views entirely dissimilar and often opposed to our own.

Typhoid fever has prevailed so widely and oftentimes with such great fatality that there are few diseases which have excited such general interest with the etiologist and pathologist. Its symptoms and phenomena have been repeatedly noted with the utmost accuracy, and the recorder of the present day must bound his aspirations, and be content, by simply *verifying* the observations of those who have preceded him. But with the analyst the case is far different; being in search of no new phenomenon, not professing to add anything to what are already cognate facts, in relation to the disease, his object being merely to interpret these facts from data founded upon them, repeated observation and record by others but strengthen and confirm his positions, and afford him a wider field and more abundant material from which to draw his conclusions.

History.—There are certain traits upon which nearly all writers have agreed as being usually characteristic of typhoid fever. In the first place there is always more or less prostration, with an impairment of the functions of the nervous system. Secondly, there is *fever*, which is continuous, but sometimes variable in its degree. Thirdly, in the vast majority of cases there is more or less diarrhœa, generally of an obstinate but passive character; and fourthly, its most constant pathological appearances have been found to be those which refer to the abdominal viscera, there being very uniformly some special alteration in the follicles studding principally the mucous membrane of the mesenteric portion of the intestinal canal known as the glands of Peyer and Brunner.

In addition to the above, which may be considered as almost essential characteristics of the disease, there are a great variety of symptoms described by almost every author as very constantly attendant upon it, and by many considered among its essential attributes. These, although very numerous, will be found generally more or less referable to one or other of three classes of symptoms, the combination of which appears to constitute the disease, viz. disturbances of the *nervous system*, of the *circulation*, and of the *digestive organs*—and so far as practicable, we will thus classify them in our summary. The symptoms pertaining to the *cerebro spinal system*, commonly denominated the nervous symptoms of typhoid fever, consist in wandering pains in various parts of the body; cephalalgia, pain in the back, loins, and extremities, more or less delirium, vigilance, somnolence, dulness of hearing, impaired vision, soreness of the mus-

cles, and occasionally subsultus tendinum, together with prostration of muscular power.

In relation to this class of symptoms our reference to statistics has been attended with various results; we find that they have generally been noted with a view to institute comparisons between the two types, typhoid and typhus, and the general result in regard to them, so far as we have been able to notice, has been; that nervous symptoms of one or other character are present in a large proportion of *typhoid* cases, but they do not generally form such prominent features in this as in the typhus type, where their existence is almost invariable, and of a character much more alarming; so that, of the two diseases, the common term "*nervous fever*" would be more applicable to typhus.

Disturbances of the Circulation are perhaps the most invariably present of the three classes of symptoms. Of these, we will notice the abnormal states of the pulse, abnormal temperature of the skin, and the capillary congestions frequently observed on the surface of the body.

The *pulse* is almost invariably more or less accelerated in both typhoid and typhus fever. In character, it is irritable, weak, and nervous, showing a remarkable contrast to the full, open, *sthenic* pulse, characterizing the paroxysms of periodic fever. Its frequency is far less than in the latter case, but it is nearly uniform; and although occasionally subject to variations, this general feature of unintermitting continuousness is so constant, that it is from this probably more than from any other feature that these types have acquired the general name of *continued fever*. The average mean of the pulse, according to the accurate observations of Dr. Flint, is $95.\frac{7}{13}$ in typhoid cases, while it was found by him to be $105.\frac{4}{9}$ in the typhus type, which I think will be found not to vary materially from the observations of others. His tables also show that irregularity and feebleness are much more common in typhus than in typhoid fever.

In relation to frequency he remarks: "There can be no doubt, if the pulse exceeds 120, except for a transient period, that the case is of dangerous severity; and the danger increases in more than geometrical ratio, if it rises above this point."

Temperature of Surface.—There is, as in other forms of fever, more or less heat of surface, in continued fever, which varies from a

little above the natural warmth to what is known technically as biting heat, *calor mordax ;* but these aberrations are so common in every form of fever, that we cannot attach much importance to them in a pathological inquiry like the present.

Sweating and Moisture, we find more common in typhoid than in typhus fever. In the former, cases vary much in regard to these symptoms; sometimes the skin will remain usually dry, having at intervals sudden profuse exudations of sweat, soon becoming dry again. In other cases, the surface will be kept in a soft and gentle moisture during the whole disease; while, again, the most profuse colliquative sweats will shrivel the surface and rapidly exhaust the strength of the patient. Upon the whole, there is a greater tendency to moisture than to dryness of surface in typhoid fever; while in the typhus type, decidedly the reverse is found to obtain.

"It would be interesting," says Dr. Flint, "to acertain upon what ulterior conditions sweating is dependent. With reference to this point of inquiry, it would be important to establish any relations subsisting between this event and other phenomena belonging to the natural history of the disease. I have examined the histories of several of the cases characterized by sweating, in order to discover a clue to some connection of this kind, but without success. It occurs not only at different periods of the disease, but apparently irrespective of the circulation, the temperature of the skin, and other symptoms. The antecedent morbid condition or conditions upon which it depends, and the circumstances involved in its production are unknown. All that can be said of its causation is, that it is an event incident to the progress of continued fever, belonging in the category with other incidental events, such as acceleration of the pulse, coating of the tongue, somnolency, &c., all of which are not more rationally explicable than it."

Capillary Congestions.—Among the ordinary appearances of continued fever, there is no one which will strike the attention of the clinical observer more forcibly than the peculiar, diffused congestions on various parts of the cutaneous surface; and though the symptom is easily recalled to our minds by a bare mention of it, yet strange to say, it has been almost uniformly omitted by reporters until quite recently. Even Louis, with all his vigilance, seems to have allowed

this symptom to escape his attention. Dr. Gerhard, of Philadelphia, appears to have made the earliest and most distinct reference to it, in his account of the epidemic typhus fever, in Philadelphia, in 1836. Published in the *American Journal of Medical Sciences*, and also in *Graves's and Gerhard's Clinical Medicine.*

"A constant symptom," says Dr. G., "observed in every case of typhus fever, was a dull livid red hue of countenance, extending nearly over its whole surface. Sometimes this colour approached a purple. It coincided with a strong, dark red suffusion of the capillary vessels of the conjunctiva, which appeared at the same time with it; but it usually disappeared at an earlier stage than the injection of the eyes. The *conjunctiva never* presented the bright tinge or the brilliant aspect observed in acute inflammatory diseases of the brain, or eye itself."

Dr. William Jenner, of University College, London, has also given recently his observations on this subject, in his work on typhus and typhoid fever. He remarks: "The conjunctivæ were more or less intensely injected in twenty-five cases; and in all of those in which the opportunity occurred of observing the date of the first appearance of the increased vascularity, it began during the second week. * * * In eleven of the cases the pupils were contracted. The expression was dull, and the bloodvessels had a dark red tinge, instead of their scarlet hue. The suffusion of the face and eyes was so constant and so well marked, in the fully formed disease, that it served almost as a pathognomonic sign. It was generally most evident in patients of a full habit of body. Towards the close of the disease, the leaden colour was gradually changed into a dull ashen tint, which remained until the entire recovery of the patient. The colour of the face when flushed (in typhus) was dusky red, and never pink as the cheeks were in cases of typhoid fever."

But it is to Dr. Austin Flint, to whose admirably accurate and faithful reports we have already referred, and upon which we must continue to draw for reliable data in this inquiry, that is due the credit of the fullest statistical account of this trait of the typhoid affection.

Inasmuch as we consider this symptom, as well as his observations in relation to it, somewhat important to the establishment of the views we have taken in regard to the pathology of the disease, we will give them somewhat *in extenso.* He remarks that these alterations of colour were evidently due to capillary congestion. They were always more marked on the cheeks than elsewhere, and

sometimes were chiefly observable in that situation. In many instances, they extended entirely over the body. He describes the redness of the face as resembling closely the appearance which the surface presents after exposure to cold, the explanation probably being the same in either instance, viz: "*retarded circulation of the blood in the capillary vessels.*"* On pressure with the finger, the redness disappears, and returns when the pressure is removed. The redness returned less quickly in proportion to its lividity or duskiness, showing that the colour is an indication of the degree in which the forces of the circulation residing in the capillary system are depressed.

In the two types of continued fever, Dr. Flint found this symptom to differ very much; being much more frequent in the typhus type than in the typhoid, and also of a much darker and more livid hue in the former. In typhoid, it was seldom more than red, whereas in typhus, it was more frequently dusky or even livid than otherwise; showing that, whatever cause acted in its production, this cause existed in greater force in typhus than in typhoid fever.

"It may be suspected," remarks Dr. F., "that the capillary congestion of the face and surface generally, is dependent on the complication of pulmonary disease, in consequence of which, the free transmission of the blood through the lungs is prevented, and its aëration compromised. With reference to this point, I have compared the pulmonary symptoms with the symptoms now under consideration, in all the cases, and find that this connection does not uniformly exist. Several of the cases in which the congestive redness and dusky tint of the face was marked, presented pneumonic complication, denoted by cough and expectoration, accelerated respiration, and occasionally by the physical signs of inflammation of the lungs; but these symptoms and signs were absent in other cases in which the appearances of the face were the same; and the lungs evinced notable disorder and inflammation in cases in which no capillary congestion is recorded in the notes. To speak with greater exactness of the cases of typhus, congestive redness of the face and marked disturbance of the respiration were associated in nine cases. The congestive redness was present without notable disturbed respiration in two cases.

"Thus it appears that the condition of the capillaries is not attributable to the morbid condition of the lungs, or to derangement of the functional activity of these latter organs. It is worthy of note,

* Austin Flint's First Report, p. 29.

however, that in typhus, in a large proportion of cases, capillary congestion is associated with pulmonary affection; while in typhoid the *absence* of such a connection appears to be the rule. It is highly probable that both pulmonary disorder and congestion of the surface, may be the effects of the same prior morbid condition. It is not likely that the capillary congestion in continued fever is limited to the surface when it is present in the latter situation. Internal parts, could they be observed, might be expected to present similar appearances. The lungs, as is well ascertained, are liable to become congested during the febrile career, and the form of pneumonitis which usually occurs as a complication of this fever, called pseudo pneumonitis, is usually supposed to result chiefly *from the passive engorgement* of these organs. This complication, however, is thought to be far more liable to occur in typhus than in typhoid fever. The morbid condition, then, whatever it may be, which determines the congestive redness of the skin is the occasion of congestions elsewhere. . . . In congestions pervading the capillary system of the general circulation, the lungs are especially prone to become involved. This is probably the fact in cases of typhoid as well as typhus, in which congestive redness of the surface is observed, but not in a degree sufficient, generally, to lead to a notable pulmonary complication or marked disorder of the respiration. The latter consequence, it would be expected, should much oftener be present in typhus, inasmuch as in this type, not only is capillary congestion present in a much larger number of cases, but it exists in a much greater degree."

Conjunctival Redness.—Very nearly allied to capillary congestions of the general cutaneous surface of the body are those of the conjunctiva and other external mucous surfaces—and indeed by many they are classed with them, as occurring at the same time and apparently as a part of the same set of symptoms. Dr. Flint, however, has shown by his records that congestions and suffusions of the conjunctiva are by no means always associated with those of the general surface, but occur independent of them: "not only capillary congestion of the skin does not exist in all cases of congestive appearance of the conjunctiva, but the latter may be absent in cases in which the former is present." He farther remarks that this does not depend on cephalalgia. This, however, does not prove that they may not both be the effects of the same pathological condition—

circumstances which we are not able to appreciate occasioning the manifestation of either exclusive of the other.

After a careful estimate of his cases and their various features under comparison, Dr. Flint inquires what is probably the *prior condition* upon which these two congestions in common depend, or in other words, what is the common proximate cause? He considers that it depends upon the morbid condition of the blood itself, and does *not* relate to the state of the nervo-muscular forces influencing its circulation in the capillary vessels. In strict accordance with his excellent statistical method, he reasons thus from the fact, that if the cause resided in the vessels and not in the blood, inasmuch as the "pulse is the thermometer of the forces presiding over the general circulation," we should expect to find the circulatory forces compromised by the disease in proportion as the pulse was found feeble, weak, and irregular; but as his records have been attended with a different result, hence his conclusion varies from what would at first appear most rational. It will be our duty, a little later in this inquiry, to refer again to these views, and to endeavour to ascertain whether the present state of our knowledge of the physiology of the capillary circulation, will not relieve us from the necessity of regarding the condition of the heart's action as only the arbitrary criterion of the capillary circulation.

Cutaneous Eruptions.—This class of symptoms being present in both the typhoid and typhus types of continued fevers, but under entirely different forms, it will be found convenient for the purposes of our analysis to institute a comparison of their prevailing characters in the two diseases. It will be found on reference to authors, that they very generally agree that in the majority of cases of typhoid fever, there is an eruption characterized by well-defined spots of a rose colour, varying in size from that of a pin-head to a quarter of an inch in diameter. Louis observed them in twenty-six out of thirty-six of his fatal cases,* and Dr. Jackson's observations, in the Massachusetts General Hospital, have been attended with similar results, viz. about two-thirds of the cases presented the eruption.† Dr. Hale, as quoted by Dr. Bartlett, found the rose

* Louis, Researches on Typhoid Fever.

† In passing, we would make the remark, though of course it has no bearing upon the object of this inquiry, that, according to our observations and those of many physicians with whom we have conferred in relation to the eruption of typhoid fever, in those cases which occur in the Southern and Middle States, even where the disease

spots in one hundred and seventy-seven out of one hundred and ninety-seven cases. Dr. Flint reports thirty-seven out of forty-eight cases in private and hospital practice. His description of the eruption is as follows: "It is generally limited to the chest and abdomen, but occasionally extends to the extremities. It may be copious, particularly over the chest and abdomen, but oftener it is the reverse, the spots being few in number. The eruption is of a rose-red colour (rose spots, *taches roses*), the spots are oval, appearing somewhat elevated. The redness momentarily disappearing on pressure."

In Dr. Jenner's description, we shall perhaps find all that is necessary to characterize this concomitant of typhoid fever: "The spots were slightly elevated. To detect the elevation, the finger had to be passed very delicately over the surface, as they had none of the hardness of the papulæ of lichen or of the first day's eruption of smallpox. Their apices were never acuminated, never flat, but invariably rounded, their bases gradually passing into the level of the surrounding cuticle. * * * They were circular, and of a bright rose-colour, the latter fading insensibly into the natural hue of the skin around. They never possessed a well-defined margin. *They disappeared completely on pressure*, resuming their characteristic appearances as soon as the pressure was removed; and this was true from first to last, from their first eruption to their last trace. They left no stain of the cuticle behind; *they never passed into anything resembling petechiæ;* the characters they presented on their first appearance continued till they vanished. Their ordinary size was about a line in diameter, but occasionally they were not more than half a line, and sometimes a line and a half. The duration of each papule was three or four days; *fresh papulæ made their appearance every day or two.* Sometimes only one or two were present at first, ran through the whole course described, and then one or more fresh ones made their appearance and vanished in three or four days, and were followed by others to last as long. The number of papulæ seen at one time on the surface was ordinarily from six to twenty; though occasionally there was only one, and sometimes more than a hundred."

has prevailed as an epidemic, these eruptions are very rarely observable, although looked for with the utmost diligence throughout every stage of the disease. This absence of eruption in cases where every other symptom characteristic of typhoid fever was present, has been so uniform that many of our most intelligent practitioners have been disposed to doubt the diagnostic importance of eruptions in typhoid fever, and to look upon them as of accidental occurrence, not having any important connection with the true pathology of the disease.

"They usually occupied the abdomen, thorax, and back, but were occasionally present on the extremities. * * * * A very pale delicate scarlet tint of the skin sometimes preceded the eruption of the papulæ, but never lasted more than a day or two; the skin resembling in tint that of a person shortly after leaving a hot bath. Rose-spots occurred in nineteen of the twenty-three fatal cases here analyzed."*

The typhus type of continued fever has been so uniformly characterized by cutaneous eruptions, that it is very often, even at the present day, classed among the eruptive fevers. Many of its synonymes indicate the frequency of this concomitant; viz., exanthematic typhus, *spotted fever*, *maculated fever*, *petechial fever*, &c., &c. And while, on the one hand, we find authors disagreeing in relation to the importance of an eruption in the typhoid type, they very uniformly, where the opportunities have been sufficient for extensive observation, agree as to the eruption of typhus being one of its pretty constant, indeed almost uniform, concomitants. Dr. Gerhard says: "It was present in thirty-two out of thirty-six whites. Of the four cases in which it was not visible, one died on the seventh day of the disease, and the others presented only slight symptoms of fever, which disappeared in four or five days. It was also visible, though less distinctly, in mulattoes, and we may infer that the colour of the skin alone prevented its appearance in the negroes."

In all of Dr. Jenner's fatal cases of typhus, forty-three in number, "*the mulberry-rash*," as he termed it, was present.

According to Dr. Bartlett, the eruption differs, in many respects, in a striking degree from that of typhoid fever. Its colour, especially after the second or third day of its appearance, is that of a duller or darker red. The spots are of a dun, dusky purplish hue; in some cases they become almost black. They vary in size from that of a minute point to a line, or even to an eighth of an inch. They are less regularly circular or oval than the rose-spots of typhoid fever. They are not elevated above the surrounding surface, and disappear but very partially, or not at all, on pressure. They are, almost always, much more numerous than the rose-spots of typhoid fever, *covering in many cases the entire trunk and extremities. Sometimes* they are spread almost as thickly as the eruption of measles.†

By Pringle, these spots are referred to in the following words:

* Jenner on Typhoid and Typhus Fevers. † Treatise on Fever, p. 220.

"There are certain spots which are the frequent, but not invariable attendants upon the fever in its worst state. They are of the *petechial* kind, of an obscure-red colour, paler than the measles, not raised above the skin, of no regular shape, but confluent. The nearer the spots approach the purple colour, the more ominous they are, though not absolutely mortal." Dr. Stewart (as quoted by Dr. Bartlett) says the rash is permanent, and does not, like that of typhoid fever, come out in successive eruptions; that it, in all cases, presents the two periods of increase and decline, and that in the more severe cases it may exhibit, during the period of increase, four different states—*florid*, *dark*, *livid*, and *petechial*. When the hue of the eruption is florid, it readily disappears under pressure; when dark, it still disappears, but more slowly; when livid, semi-petechial, or pseudo-petechial, it is only partially effaced; and when petechial, it is not in the least affected by pressure. Dr. Henderson, of Edinburgh, has also noticed, that the progress and development of the eruption corresponded with the severity of the other symptoms of the disease, and that the decline of the eruption was nearly simultaneous with the first symptoms of convalescence; and, that the mortality and duration of the disease were in a very remarkable correspondence with the abundance of the eruption.

Dr. Jenner describes three stages, through which these spots pass from their commencement to their perfection—he calls them the mulberry-rash peculiar to typhus fever; says they are never papular; that each spot is slightly elevated, and of a dusky-pink colour, flattened on the surface, with no well-defined margin, but irregular in outline, and in this stage it disappears completely on pressure. Size, from a mere point to three or four lines in diameter. In two or three days they become darker and more dingy than on their first appearance, and now they only *fade* on pressure, but do not disappear. In the third stage they become dark purple, and remain unaltered by pressure, although their circumferences still fade. Sometimes they are changed into true petechiæ, or spots presenting the following characters: "A dusky crimson or purple colour, quite unaffected by pressure; a well-defined margin, and total want of elevation above the level of the cuticle."

Dr. Clymer, in his work on fever, thus describes these spots:—

"Their resemblance to flea-bites is such, that on the one hand the latter are often mistaken for petechiæ, while on the other hand some physicians will insist that real petechiæ are nothing else but flea-bites. The two appearances, however, cannot be mistaken by a care-

ful observer, &c. Sometimes the petechiæ are few in number, and escape notice; in other instances, on the contrary, they are very much crowded. This appearance is owing to a *thin stratum of extravasation* on the surface of the true skin, and appears connected with increased force (?) of the circulating system, being most characteristic when reaction is high."

It will be observed that we have classed in our summary both the capillary congestions, and those of the surface, and the various eruptions incident to continued fever, under the common head of aberrations of the circulatory system; and although this has not been the order in which we have usually found them considered by authors, we have still retained it, inasmuch as we regard these two classes of phenomena as dependent upon causes very similar, if, indeed, not identical in their nature, viz.: Impairment of the nervous forces, from which the capillary system of the surface obtains its functional endowments. That the capillaries possess a nervous motive power, independent, and not in all cases correspondent with the heart's action, many facts both in experimental physiology and in pathology would go to corroborate. The exact nature and source of the nervous power are subjects foreign to the present part of our inquiry, and we therefore forbear here to discuss them.

On making a comparison of the cutaneous congestions and eruptions occurring in these two forms of continued fever, the following seems to be the result of our analysis of the foregoing summary of the observations and opinions of our best authors:—

Firstly. That both capillary congestions and eruptions of one or other kind are present on the cutaneous surface in the vast majority of the cases in both the typhoid and typhus type of continued fever.

Secondly. That these phenomena are more characteristic of typhus than of typhoid fever.

Thirdly. That those of typhoid fever are of a less serious character—more nearly resembling the healthy action of the capillaries than those of typhus, as evinced in the *congestions*, by the more florid and natural colour of the surface; showing that the blood, although circulating abnormally, still retains nearly its proper amount of oxygen—*i. e.* its retardation is not so great as in the typhus type, when the congested surface is "dark," "purple," "livid," and "dusky," "*resembling in appearance the cutaneous surface when its circulation is retarded from exposure to cold.** In the *eruptions*,

* Dr. Flint's First Report on Continued Fever.

the same kind of attributes indicate that the aberration is of a less serious nature in typhoid than in typhus—the spots are very few in number, and often absent altogether, very rarely extending to the extremities; they are simply of a reddish or pink colour, which readily disappears on pressure, returning when the pressure is removed; while in typhus fever they are very numerous, generally appearing on the extremities as well as on the body; they not only arrive at the stage of simple congestion, but they go beyond that point, do not yield to pressure, and, finally, after a continuance of some days they become true *petechiæ*,* regular hemorrhagic spots, evidencing extravasation,† and, of course, a certain degree of disorganization in the vessels.‡ Again—If we look at the character of the two eruptions in another light, the same opinion of their relative gravity must obtain; the typhoid papula is an *elevated* object on the surface of the skin—the elevation is the result of an elimination *from the* blood, caused by a *kind of inflammation*, which is always a phenomenon occurring under vital influences: this pseudo-inflammatory process subsides by effusion, and one crop of papulæ is succeeded by another, which observes the same course, till the recovery or death of the patient; but in the typhous petechiæ these phenomena are absent, or, at least, only present on the first or second day, for they soon give place to others which are the evidence of more serious obstruction, and which are of such a character that their occurrence does not necessarily imply vitality in the parts wherein they occur. Thus we may say that, in *typhoid* fever, the redness of surface generally, and the eruption, may be termed true *congestion*, while the

* Dr. Stewart, as quoted by Dr. Bartlett. Also Jenner, on Typhoid and Typhus Fevers.

† Clymer on Fever.

‡ On this subject we find Vogel expressing himself, in his section on the various forms of hyperæmia, in the following satisfactory manner:—

"In typhus, petechial, and putrid fever, &c., the extravasation of true blood is very frequent, *but is always dependent* on *laceration* of the vessels; and in producing this laceration, a change in the composition of the blood can only act a very secondary part. It can only act through a series of means, by favouring congestion and stagnation of the blood." And in another place he says: "Extravasated blood always proceeds from the vessels, and results from their laceration. The view that, at least some of these effusions of blood may occur without any injury of the vessels, by a mere transudation of the blood through the attenuated vascular walls (diapedesis), is altogether untenable, although some even of our recent authors (Carswell among others) still support it. The walls of the bloodvessels—even of the smallest capillaries—are so impervious, that it is impossible for such large particles as the blood-corpuscles to pass through them in an uninjured condition."—*Path. Anatomy*, p. 93.

livid-purple tint, as well as the maculæ of *typhus*, are as plainly the result of true *stasis*."*

Disturbances of the Digestive Organs.—Under this head could be classed many of the symptoms characterizing typhoid fever. In the earlier part of the disease there is often loss of appetite, thirst, nausea and vomiting, together with a great variety of other symptoms, indicating a disordered condition of the nutritive apparatus; but the symptom which it is our object here more particularly to dwell upon, and the one which has been admitted by all to constitute an important part of the disease, if not the disease itself, is diarrhœa.

Louis reports it as present in all but three of his fatal cases; and in relation to the time of its commencement, his statistics show that out of forty fatal cases, from which he was able to obtain information on this point, twenty-two had somewhat frequent and liquid dejections on the first day of the disease. And in all the cases which died, lesions of the small intestine were the only constant pathological appearances, and these were always the first, so far as was appreciable, to commence. In favourable cases, the diarrhœa is sometimes absent, or makes its appearance quite late. There also appears to be a marked correspondence between the severity of the disease and the prominence of diarrhœa in any given case. Thus, in the eighty-eight favourable cases given by Louis, fifty-seven were found to experience severe symptoms, and thirty-one, slight ones; out of the fifty-seven

* Vogel, again, is very plain on the above point, as well as in reference to the source from which these vessels derive their energy. His remarks express well what we would indicate in relation to these two states of the capillaries. "In many cases capillary hyperæmia is undoubtedly dependent on the nervous system; this, from whatever cause it is induced, gives rise to dilatation of the capillaries, and relaxation of their walls; the dilated capillaries receive, on purely mechanical grounds, more blood than they previously did; and a capillary which in its normal condition could admit of the passage of only a single row of corpuscles, may now admit of two or three. At the same time an excess of plasma escapes through the attenuated walls of the capillaries. [Hence the papulæ of typhoid fever are elevated by this plasma.] The part affected contains an excess of blood-corpuscles, and hence appears reddened. This is the condition which is known in pathology as *congestion*—it frequently occurs in the living body in external parts, as in the face, the eye, or the skin. * * * As that form of capillary hyperæmia in which there is no stagnation of the corpuscles is termed *congestion*, so *the higher degree* (where they *stagnate*, and the local circulation is arrested) is termed *stasis*." In the same place he also indicates it as his opinion, that this passive or hypostatic hyperæmia is the result of nervous depression. Who could ask a more exact portraiture than the above, of the cutaneous phenomena in the two types of continued fever?

subjects who had more or less severe symptoms, twenty-four had diarrhœa from the commencement of the disease, which will be found to be a somewhat smaller proportion than obtained in his fatal cases. Among the other patients, five had it on the second day, three on the third, four on the fourth, &c. &c.; in two cases, it appeared as late as the 18th and 30th days, but these were very mild cases, the only symptom of the disease being loss of appetite, weariness, loss of strength, &c., which continued for twenty-five days in one of the cases; indeed, we can hardly regard these as cases of typhoid fever, until after the supervention of the diarrhœa.

The length of its duration is variously reported by authors; the sum of Louis's severe cases would show an average of about four weeks, which, perhaps, would be found in any estimate made from so large a number of cases, to be about its ordinary duration. The reports of most writers favour the opinion that its duration is equal to that of the disease itself, beginning with its access, and generally continuing in a more or less degree till after convalescence is fairly and fully established.

The number of the discharges will be found to vary from one or two to twenty or thirty a day; and a cause of great discrepancy in reports of the disease in relation to this symptom, has been that many authors do not regard liquid but infrequent stools as cases of diarrhœa; while others, among whom is Louis, regard all cases, wherein the *thin* passages are found, as presenting the complication of this symptom. We do not think it necessary here to argue which mode of estimating is proper, but for our purposes, the plan of determining by the *quality*, rather than by the *number* of the discharges being most available, we have considered all, as cases with diarrhœa, whenever the discharges were of a liquid character, independent of the action of cathartics. Inasmuch, as our pathology of the disease is more plainly indicated by the aberration in the secretion, than by any other circumstance in this connection, we have considered this pathological condition more or less present, whenever this aberration has been found to exist, and in this view, we are corroborated by the observations of all our best and most philosophic observers, Bretonneau, Chomel, Louis, Bartlett, Jenner, and Flint; and, indeed, every fact in regard to this subject corroborates the opinion, that it is the character of the stools rather than their frequency, which marks the existence of intestinal lesion in typhoid fever.

The stools are generally of a liquid character, of a yellowish or dark-brown colour, more resembling, according to Dr. Bartlett, new

cider, than anything else. Louis speaks of them as being like coffee-grounds; perhaps the best description we can give, is that they resemble muddy coffee, more nearly than any other liquid. All authors seem agreed that they in general contain but little or no mucus, and but seldom resemble in character the discharges found in ordinary diarrhœa, and that they are seldom complicated with those of a dysenteric character. Their odour is fetid, though not invariably so. There is frequently more or less blood found mixed with the passages. In two cases reported by Louis (Obs. 18 and 44), the blood was pure and fresh; in the majority, it presented the appearance of being coagulated, and gave to the evacuations the appearance and consistence of coffee-grounds, which he says is very remarkable, inasmuch as evacuations of this nature were seldom if ever observed in the course of acute diseases, other than the typhoid affection, and because, when we may be in doubt as to the nature of any disease, their existence will contribute very much to make the diagnosis more clear and satisfactory.*

Pain in the Abdomen.—In connection with the diarrhœa, abdominal pain is found to be a very common attendant on typhoid fever. It occurs most frequently in the right iliac fossa, in the hypogastric and umbilical regions, and is generally in direct relation in its severity to that of the diarrhœa. It is oftener of a dull aching character than otherwise, and sometimes there is only a slight soreness on pressure. These pains and their relations to the lesion of the intestinal canal, have been very fully considered by M. Louis, who thinks that they indicate a diseased condition of the mucous membrane of the small intestine with scarcely less certainty than does the diarrhœa itself. In a great number of his patients, these pains began before the diarrhœa, often on the first day of the access of disease; and though they were generally very shortly succeeded by diarrhœa, yet not invariably, nor should we necessarily expect them to be, inasmuch as we know full well that in true enteritis, diarrhœa does not uniformly occur on the first day, although the seat of the inflammation is in one or other of the intestines.† Dr. Bartlett describes them as continuing frequently through the whole course of the fever, and as being often the only cause of distress to the patient.

Meteorism or *tympanites*, is an intestinal symptom, to which M. Louis and most authors attach the greatest importance. The flatulent distension of the abdominal parietes was found by him to occur

* Louis. Part III. page 18.

† M. Louis. Part III. Chap. 1.

in thirty-four out of forty-six cases of the disease. It was variable in its time of coming on; sometimes within a few days of the attack, but generally much later. By a few writers, in which number is Dr. Hale,* of Boston, it is reported as occurring most frequently quite early, but Dr. Bartlett says this is entirely opposed to his own observation and the experience of many of the best authorities.

"It varies in degree," says Dr. B., "from a slight rigidity of the muscles and straightness of the parietes to the extremest distension; in such cases occasioning, by its mechanical action on the lungs, no inconsiderable degree of dyspnœa. It generally persists after its first appearance till the fatal termination, or the approach of convalescence; although it is not usual for it to vary considerably in degree, at different periods of the fever. The flatus rarely passes off per anum, and seems to be but little disturbed by the peristaltic motion of the intestines."†

In relation to its diagnostic value M. Louis remarks: "In the same proportion that meteorism was frequent in individuals attacked with typhoid fever, so it was rarely observed in the course of other acute diseases. Out of eighty subjects, the greater part of whom had diarrhœa, six only had meteorism; four pneumonic patients out of fifty-six had some meteorism during three or four days also; but only two out of forty-six attacked with eruptive diseases, had any meteorism." He did not meet with this symptom in other acute diseases, even in any one of the eighty-six cases of enteritis, properly so called, whether more or less severe. In speaking of the cause of this complication, M. Louis says: "Although in the actual state of our science, I cannot assign any cause for meteorism, I would, nevertheless remark, that it seemed to me to follow a law which was analogous to that by which other symptoms were governed; since, as in those attacked with the typhoid affection, its frequency and force were proportionate to the degree of severity of the principal disease; and among the others, those alone had it in whom the febrile excitement was the most marked; at least such was commonly the case."‡

Pathological Lesions.—For the description of the anatomical lesions of typhoid fever, various plans and classifications have been devised; but as, in the present inquiry, it is indifferent as to the result what mode we adopt, we have chosen that which seemed most con-

* Medical Communications, Massachusetts Medical Society, 1839.

† Essay on Fevers, page 76.

‡ Louis. Part III. page 36.

venient, and which would place those particular changes from which we deduce our views of the pathology of the disease in the most distinct relation with the other data under consideration. Many of the pathological changes observed in this disease are considered by authors as merely of an accidental or occasional nature; while others, from their frequency, indeed invariableness, have been regarded as the essential lesions of typhoid fever.

The Brain and its Membranes are seldom the seat of any very important lesion in this disease, which fact is very surprising when we consider the amount of functional derangement so constantly present. When these lesions exist, they are not of a character which shows any important relation to the phenomena of the disease, nor are they at all proportionate to the severity of the symptoms which pertain to disturbed functions in these organs. Chomel examined the brain and its membranes carefully in thirty-eight cases; there was no appreciable alteration whatever in fifteen cases. The other cases presented nothing very striking; serous effusions, more or less vascular injections in the membranes and brain itself being their chief characteristics.* Dr. Flint, of Buffalo, has also made the report of a few cases wherein he has made careful examinations of these facts, but with results not materially varying from those of other authors; in no case was there any softening of the brain itself.† Louis examined forty-six cases. There was subarachnoid effusions in twenty-eight, vascularity and more or less injection in the remainder.

In relation to this class of lesions Dr. Bartlett remarks, "there is no ascertained relation between the cerebral symptoms during life and the pathological conditions of the brain and its membranes after death. Delirium and somnolence are found to have occurred as frequently, and to have been as strongly marked, in patients whose brains presented no changes, or exceedingly slight ones after death, as in those of an opposite character. Again, it is obvious that these lesions are in no way peculiar to typhoid fever, since they are found almost as frequently in patients dead from other acute diseases, excluding those of the brain itself and its envelops, as in those dead from fever."‡

The Heart and Circulating Apparatus were found altered in about half of Louis's cases, the alteration consisting in the substance of

* Chomel, Leçons de Clin. Med. p. 294.

† First and Second Reports on Continued Fever.

‡ Treatise on Fevers, p. 90.

the heart being of a pale colour and soft flabby consistence. In seventeen of his cases (in number, forty-six) the softening was so well marked that the tissue could be readily broken down. This softening was generally accompanied with great flaccidity of the organ, though they would occasionally exist separately.* These alterations, according to most authors, are accompanied by changes of colour, the substance of the heart becoming pale and sometimes of a livid or violet tinge. Dr. Jenner's examinations also corroborate the above, a good proportion of his cases presenting the same alterations.† The condition of the heart does not differ very materially in the two types of continued fever, it being found "flabby, soft, easily broken down in the typhus as in the typhoid variety." Here, perhaps, we can more appropriately than elsewhere notice the condition of the voluntary muscles, between which and the condition of the heart there is found a remarkable difference. We find no account elsewhere than in Louis's researches. He remarks: "I examined the muscles which govern the voluntary movements, in nearly all the subjects, and I found them nearly always natural with regard to colour and consistence; and this is the more remarkable, inasmuch, as I observed before, the *heart* was more or less seriously softened in a great number of cases. (Vol. i. p. 352.)

Louis describes the internal surface of the aorta as changed in colour in more than half of his cases. The alteration consisted in patches of morbid redness, sometimes very bright, and extending from the ascending aorta to its bifurcation, and even sometimes beyond it. The discoloration extended generally deeper than the lining membrane of the vessel, and was proportionate in its intensity of colour, and also in the amount to which the coats were involved, to the degree of flaccidity and softening of the heart.

Louis remarks in relation to this feature; that "the colour of the aorta has been particularly investigated of late by many distinguished physicians. Some have considered the red colour as simply the effect of *imbibition*, met with in violent deaths as well as in various diseases; others have regarded it as the result of inflammation on which depended a series of symptoms called inflammatory fever. But the facts we have just analyzed cannot, it seems to me, be accounted for under either of these hypotheses." He then asks: If it be simple imbibition, why is the aorta not discoloured in all

* Louis's Researches on Typhoid Fever, vol. i. p. 331.

† Typhoid and Typhus Fever, p. 80.

cases where blood is found in its cavity? On the other hand, if it is inflammation, why did not these patients present symptoms different from those the aorta of which did not present these discolorations? He finally seems inclined to the opinion that it depends upon the imbibition of the blood, but that the special alteration which it has undergone in this disease is a necessary prerequisite to the imbibition.† The most rational explanation of the above appearance, to our mind, is that it is dependent upon the same condition of the small vessels supplying the walls of the aorta, the vasa vasorum, which operates in the minute cutaneous capillaries in the production of the spots and congestion on the cutaneous surface; for we know there are many diseases in which similar alterations of the blood occur as in typhus, and yet no such discoloration is observed in the aorta.†

The Lungs have been found very frequently presenting marked and peculiar alterations. Louis found them nearly natural in fifteen out of forty-six of his cases, which he says is the proportion in which he found them affected in other diseases, excluding of course those of the lungs themselves. Chomel reports ten in forty-two cases. Dr. Jenner says that "congestion is very frequent in those dead from typhoid fever, and rare in those from typhus fever." He calls it the lobular non-granular consolidation of the lungs, which he thus describes: "Externally, a portion of lung in this condition has a mottled aspect; here and there patches, varying in size from a single lobule, to half or more of a lobe, of a deep bluish, chocolate, violet, or purplish slate colour, bounded by a well-defined angular margin, crossed, if it includes more than one or two lobules, and mapped out into smaller patches by dull opaque whitish lines. * * * Scattered in the midst of the larger patches are frequently found one or more healthy lobules." Dr. Flint describes this condition of the lungs as a sort of pseudo-pneumonitis, which probably results from the *passive* engorgement of the lungs, and seems to think it more frequent in typhus than in typhoid fever.

Dr. Bartlett says also, "that it is quite unlike, in almost every

* Louis's Researches on Typhoid Fever, 291.

† Andral and Gavarret have made four analyses of the blood of three persons suffering from scarlatina, which indicate decidedly the existence of hypinosis. Lecanu has also made two analyses of the blood in this disease, and has obtained nearly similar results.—Simon, *Chemistry of Man*, p. 246. Hassall also places smallpox, scarlatina, and measles in the same category, and describes the character of the blood as nearly identical in all, in this respect.—*Microscopic Anatomy*, vol. i. p. 147.

respect, the secondary stage of inflammation, although the term hepatization has sometimes been applied to it. It is not indicated by any peculiar symptom during life, and he farther expresses the opinion that neither the symptoms nor the lesions go to show that the lungs play any very important part in the numerous and complicated phenomena of typhoid fever;"* but from the comparative uniformity of their occurrence we are disposed to form a somewhat different opinion, and to think their frequency and character are such as to allow the deduction that the lungs, like many other viscera, are immediately under the reign of those morbid influences or conditions upon which the disease depends.

The state of the blood is very properly accounted as being among the anatomical changes, though examinations of this fluid are generally made previous to the death of the patient. From the numerous examinations of Andral and Gavarret, besides many others, the blood appears to exhibit the characters of hypinosis; one of the characteristics of which state is diminished fibrin; more frequently in typhoid and typhus fever than in almost any other disease. The blood in this disease, says Simon, is very deficient in fibrin, and frequently also in albumen. It coagulates imperfectly and often remains in a semifluid state, and when a clot is formed, it is soft and scarcely ever covered with a buffy coat. The character of the blood appears to be very much the same in the typhus as in the typhoid type of continued fever, as likewise are the pathological lesions referring to the heart. Blood more generally dark in the former. The state of the blood in the typhoid affection, however, is not uniform, for, as Simon remarks, it varies much at different times, which has been the cause of much discrepancy in the accounts of various authors; thus, in the stage of excitement, instead of having too little fibrin, it is often found to contain more than in the normal state, becoming then in the opposite condition of hyperinosis. From this it would appear that the state of the blood in the typhoid affection cannot be of the paramount significance that many authors would claim for it; for during the times that this fluid is presenting these very opposite chemical and physical attributes, the main characteristic phenomena of the disease do not appear to be at all altered in correspondence with them, and therefore must depend upon some other influence than the state of the blood for their continuance, otherwise they would be subject to interruptions. If they depend

* Treatise on Fevers, p. 87.

upon hypinosis, reason would not tolerate the supposition that they remain unaffected during hypinosis.

Abdominal Viscera.—The changes which occur in these organs are by far the most important incident to the disease, and hence we have as one of its synonymes typhus abdominalis; indeed, if we except the weak and accelerated pulse and the altered condition of the heart and blood, nearly all the phenomena, both symptomatic and *post mortem*, may be said to refer to the abdominal viscera.

The spleen, with only four exceptions, was more or less seriously changed in all of Louis's cases. Its structure was ordinarily softened, sometimes thickened, and frequently four or five times larger than natural. Dr. Jenner says, "that it was enlarged in all his cases of typhoid fever; softened in one-third of the cases only." Dr. Bartlett reports it as more frequently enlarged in typhoid than in typhus fever.

The liver was softened in half of Louis's cases, in some to a remarkable degree. Dr. Jenner says that this again, together with the pancreas and kidneys, were more flabby in the cases of typhoid than of typhus fever. There was an ulceration in the lining membrane of the gall-bladder in one of fourteen cases of typhoid, and in nine of thirty-one cases of typhus; in the latter disease, the bile was much more thick and of a darker green colour than in the former disease. Dr. Bartlett adds, that this difference in the appearance of the bile in a large majority of cases is well marked in the two diseases.

The *urinary bladder* was found ulcerated in one of Louis's cases, and also in one of Dr. Jenner's cases of typhoid, but in no one of typhus fever.

Under the head of Organs of Respiration,* Louis describes various changes in the epiglottis, glottis, larynx, and trachea; such as ulceration, red patches, &c. &c., and remarks, that with the exception of that of the trachea, all the mucous membranes were more or less thickened, reddened, softened, and a certain number of times *ulcerated*, in patients who died of typhoid fever.

The *pharynx and œsophagus*, in a large proportion of Louis's cases were found in a healthy condition, but there occurred with considerable frequency ulcerations of the mucous membranes of these parts; in the case of the pharynx, in a proportion of rather more than one-sixth of the cases. These ulcerations varied from one to

* Louis, Researches on Typhoid Fever, vol. i. p. 294.

six or eight lines in diameter and were various in their contour; generally superficial. In relation to these changes, Louis remarks: "Ulcerations of the pharynx and œsophagus having occurred only in a small number of typhoid patients, and in no other disease, may be considered among the anatomical characteristics of the former; *though they are secondary*, these are very important characteristics, nevertheless, because it would be only necessary to find ulcerations in the pharynx or œsophagus in a patient who died of an acute disease in order to be almost sure of the nature of that disease."*

Dr. Jenner found inflammation with or without ulceration of the larynx and pharynx present in about half his cases. His analysis leads him to the conclusion that the laryngeal inflammation is secondary to the pharyngeal, and that laryngitis, independent of pharyngitis is extremely unfrequent in typhoid fever.†

Lesions of the Alimentary Canal.—Of all the anatomical changes pertaining to typhoid fever, there are none so peculiar and characteristic of the disease, none which are so plainly and unmistakably indicated by the symptoms during life as those which refer to the alimentary canal. So constantly do these lesions attend the peculiar phenomena which characterize typhoid fever, that at the present day, the one and the other set of facts are considered as invariably constituting essential parts of the disease, and in many instances these are the only characteristics which determine the positive existence of typhoid fever; so that these changes have become the terms by which the disease itself is indicated, as dothinenteritis, follicular enteritis, &c.

The stomach was found to present *post-mortem* changes in about two-thirds of Louis's cases. The alterations of which it was the seat consisted in changes of colour, consistence, and thickness. It was sometimes mamellonated, and four of his cases presented ulcerations; these ulcerations were small in size, superficial, and not very numerous. Chomel found various changes in the mucous membrane of the stomach, but was not able to discover ulcerations. Dr. Flint describes a remarkable and to us an important *post-mortem* fact as occurring in several of his cases, which we have not been able to observe in the reports of others. It is the presence of *ecchymoses*, of more or less extent, in the mucous membrane of the stomach. He

* Researches on Typhoid Fever, vol. i. p. 383.

† Bartlett's Treatise on Fever, p. 91.

speaks of them as presenting "punctated redness, or ecchymoses," and expressly states that there was "no *capilliform* redness" in the cases where this appearance was observed. "The mucous membrane," he says, "was softened; several ulcerations, varying in size and form, the largest half an inch in length and three or four lines in width, superficial, apparently having penetrated only the mucous coat. These appearances were limited to the larger curvature. The organ at this part was easily torn, a rent occurring in removing it from its spinal attachments." In another case he again remarks, "the stomach, on its internal surface, presented *several patches of ecchymoses.*"*

Louis, who has paid great attention to the gastric pathological appearances, was not able to make out any very important relationship between them and the gastric symptoms previous to the death of patients in whom they existed. He observed that in many cases the lesions existed after death, where there had existed no gastric indications of their presence during life, and that distress in the epigastrium, with nausea and vomiting, often existed when the mucous membrane was found healthy. Chomel was alike unsuccessful in establishing any constant relationship between these two sets of phenomena. Flint makes a similar remark with regard to a few cases in which he made *post-mortem* examinations; thus, "in two fatal cases in which the stomach exhibited lesions, ulcerations in one of them, vomiting is not noted to have occurred."†

From this feature of non-correspondence between the symptoms of irritation in the stomach and the amount of gastric congestion and ulceration, together with the peculiar character of the congestions, as just noted from Dr. Flint, being of a hemorrhagic or ecchymosed character, we would reasonably infer that they are *passive* in their nature, and seldom dependent on nervous *irritation* of the stomach, but are the result of passive engorgement of the vessels; and, indeed, when closely considered, all the mucous congestions pertaining to typhoid fever, will be discovered to be markedly of this passive character, and but little or not at all productive of irritation. There is deficiency rather than excess of action in the vessels, and the nervous susceptibilities of the mucous surfaces appear to be unaccountably obtunded, to what would rationally be expected to act as causes of great irritation, such as ulcerations, thick-

* First Report on Continued Fever, pp. 128–129.

† First Clinical Report, p. 79.

enings, &c.; as we have just seen that ulcerations exist in the stomach without vomiting, and in many cases of congestion elsewhere, as in those of the conjunctiva, when it did not increase the susceptibility of the eye to light.* And again, in the cases of diarrhœa, the urgency of the evacuations was not very pressing, inasmuch as it was often necessary to call the attention of patients to the subject, by asking them if they did not desire to evacuate the bowels.† We never observe in the diarrhœa of typhoid fever anything like the tenesmus, so common in other forms of enteric disorder; and yet the amount of actual disease in the intestine is far greater than in many of them.

The Small Intestine.—The characteristic lesion of typhoid fever, and, of course, by far the most interesting of all the anatomic changes observed in this disease, is found in the small intestine; its existence is invariable, and in many instances it is the only distinguishing trait of the disease. It consists of changes, varying in character, in the mucous follicles, known as the glands of Peyer, found along the mesenteric portion of the canal. The character of these alterations has been found to vary very much, in proportion to the duration of the disease and their distance from the ileo cœcal valve, where the follicles are uniformly the subject of more serious alterations than elsewhere. Louis found the elliptical patches of the ileum more or less seriously changed in structure in all the patients the report of whose cases he subjected to analysis. The region in which they were infected, varied from the last two to eight feet of the canal. They were affected throughout the whole length of the canal in one case only. His description of these changes is more extensive and minute than we consider necessary for the purposes of our analysis, but we will give the substance of them in this place.

He found that the changes, from a healthy condition of the patches to an alteration of structure, took place sometimes, in a gradual manner; but generally it was the reverse, and with all, or nearly all, the different degrees of the lesion were found in the same patient. In passing from the patches which were least altered to those which were most so, he found that they presented the following appearances: the first were very slightly elevated and pale, or of a faint rose colour; the orifices of the crypts were obliterated, and there was slight softening of the mucous membrane; next, came patches in which the thicken-

* Flint's First Report, p. 53. † Ibid. p. 83.

ing, softness, and redness were more marked. "The first of them had in some cases a surface which was granulated, upon which was seen a greater or smaller number of the open orifices of the crypts. In this state of alteration the most remarkable effects of the lesion was the development, and, if we may so express it, the *exaggeration of the natural structure of the parts.*" The patches were raised, and also the mucous membrane which aided in its formation. The submucous cellular tissue was more or less affected, and of a pale rose colour.* These conditions became more and more marked and exaggerated—that is, the patches became thicker, redder, and softer, till various stages of ulceration are detected; some superficial, and just commencing, with an imperfect destruction of the mucous membrane; others deeper, with its entire destruction. Sometimes they are distinct, at others they run into each other, so that the entire destruction of the mucous membrane over the whole extent of a patch is thus produced. The submucous and muscular coats also participated in these alterations, and the peritoneum became ruptured. Sometimes these alterations took place very rapidly, and perforation of the intestine would result at an early stage of the disease.

In many of the cases which died late in the disease, he found evidences of a reparative process having been set up in these ulcerated patches, and this was always more marked in that region of the intestine in which these ulcerations had begun, viz., the vicinity of the cœcum. In addition to the above, Louis also describes other changes that relate to the elliptical plates, which, he says, are peculiar to the submucous tissue. "Instead of being simply somewhat reddened and moist, without other change of structure—instead of partaking in some measure of the inflammation of the mucous membrane which covered it, as in the preceding variety, the cellular tissue was transformed, either through the whole extent, or nearly the whole extent of the patches, into a homogeneous substance, without apparent organization, of a pale rose or yellow colour. It was from two to three lines thick.

"It was easy to see that this substance was not secreted *from the surface* of the submucous tissue, *but into its substance*, on making an incision through it. These deposits were covered by mucous membrane, more or less reddened in proportion to its advance towards ulceration, which was the ultimate tendency of the parts in which they occurred." Louis says these deposits occurred in some-

* Louis's Researches on Typhoid Fever, vol. i. p. 174.

what less than one-third of his cases. In relation to the character of the deposit, M. Vogel remarks: "This must in every case be deposited in a fluid state, and subsequently assume the solid form by coagulation; otherwise, it would not so completely fill up all the interstices between the tissues. Upon examination, however, it is always found coagulated; at least, I am unacquainted with an instance where it was observed still fluid." Again, he says: "The question of the origin and signification of this typhus matter can only be partially answered by pathological anatomy." It appears to be ascertained that this matter is secreted in a fluid state from the *capillary vessels*. *Moreover*, the cause of this separation is doubtless a local hyperæmia of the vessels; which, indeed, may be readily proved by direct observation. The secreted matter is therefore a part of the blood, which, shortly after its separation, coagulates. But we are acquainted with no principle of the human body which is capable of spontaneous coagulation, but fibrin. Of this, therefore, the typhous matter must principally consist—it is, as in similar cases, pervaded by the other elements of the blood.

"The question here suggests itself—Is this fibrin normal, or has it undergone a specific change? The possibility of such a change cannot be denied, since we know that fibrin is very transmutable; but the assumption of such a change, without a demonstration of its nature by organic chemistry, is of no advantage in a scientific point of view. By such a hypothetical transmutation of the fibrin, we may endeavour to explain—*Why the typhous deposit is not converted into normal pus, but breaks up without any distinct organization.*

"To this view may be opposed another, equally plausible. *It is* very probable that, in typhus, the *normal properties of the tissues are deprived of their ordinary energy*, and that the *formative* power is impaired. In this diminished *energy of the original tissues may likewise be sought the reason* why *the exudation does not become organized, but undergoes disintegration.* With this brief view of the subject, I wish to express myself as opposed to the opinion that there exists in the blood a specific typhous matter, with the deposition of which (in certain parts of the body) the disease localizes itself, and terminates."

From the above, it would be plainly inferred that the deposit depends upon a congestion or hyperæmia of the capillaries of the mucous and submucous tissues differing in character from inflammation—rather a condition of stasis similar to what has been observed

in the capillaries of the cutaneous surface in the typhus type of continued fever.

Another variety of disease in these follicles is mentioned by Forget under the name of *gangrenous*. The substance of the gland loses its vitality and becomes of a yellowish or greenish colour; its edges, growing ragged and shreddy, are detached, and finally the entire gland is thrown off. Dr. Jenner says that "when the whole of the deposit has sloughed out no fresh deposit is formed, and consequently, as the whole of that deposit is seated in the submucous tissue, destruction of the muscular fibres of the intestine must be the result of simple ulceration."

In addition to the above alterations in the small intestine, which refer exclusively to the glands of Peyer and Brunner, there are other conditions of this viscus which we consider no less important in an impartial analysis of the phenomena of typhoid fever. We refer to the congestions of the *general* mucous surface independent of the elliptical patches. It has been so uniformly the habit of pathologists since the time of Louis and Chomel, to regard every other abnormal appearance in the mucous surface of the small intestine as entirely of a secondary nature, that though we find, it is true, a sufficiently accurate description of these changes, yet certainly no stress is laid upon them, nor are they generally allowed to have any important significance in the pathological relations of the disease. It is not our object to give any very extended and minute description of them, but having formed views somewhat peculiar in regard to the ultimate pathology of this disease, and regarding this condition of the mucous surface as affording a corroboration of those views, nearly as strong as that afforded by the follicular changes themselves, we would, on no account, pass them over without decided reference. Thus, we find the mucous membrane, independent of the elliptical plates and isolated follicles, to be, in a majority of cases, preternaturally red. This redness is sometimes continuous, at other times it is in zones or patches. It sometimes extends over a large portion of its tract. In some cases, where there has been hemorrhage from the bowels, blood is found in the intestine, and in addition to this, the mucous membrane is the subject of *sanguineous infiltration*, and *this condition of the membrane is observed where there has been no hemorrhage*. It may exist to the extent only of a few inches, or of several feet. It is generally continuous, not in patches or zones. The colour of the membrane ranges from a rose to a very dark red, and it has a peculiarly brilliant and trembling or quivering

appearance, like jelly. Chomel found this lesion in seven out of forty-two cases. He is very confident that it is intimately connected with the hemorrhage from that portion of the membrane which it occupies.*

The point in reference to this condition of the mucous membrane to which we would call attention, is this: that it indicates most positively an enfeebled condition of the bloodvessels, resulting in that complete stagnation of the blood which is denominated *stasis*, and the analogue of which we described somewhat at length, as occurring in the cutaneous congestions of the typhus type of continued fever. And not only do we claim this appearance after death as corroborative of this view, but in as strong a degree do we attribute the hemorrhages to the same condition of the vessels.

There is one more point in relation to the small intestine and we have done, and that is the almost entire exemption of the *duodenum* from ulcerations and the peculiar lesions of typhoid fever. Louis's reports show that this portion of the small intestine was healthy in nearly all his cases, with the exception of being somewhat reddened and sometimes softened, but rarely ulcerated.

The Large Intestine was found the subject of pathological changes in a good number of cases. Besides the condition of meteorism, which was very common, its mucous surface was found reddened with more or less deep shades; also thickened and softened conditions were not uncommonly met with. Louis says: "The parietes of the large intestine became thicker than usual, sometimes resembling the condition in which we find the coats of the small intestine in *strangulation*. . . . Its mucous membrane was white in thirteen of his cases, and red, over a certain extent, in twenty, grayish in nine; it was of its usual consistence in one-fourth of the cases; it was softened, in various degrees, over a greater or less extent of surface, and was sometimes thickened in the others. Eight presented a certain number of lenticular crypts, few of which were ulcerated; four had hard, some rounded patches similar to those of the ileum; fourteen had ulcerations, which were generally few in number, superficial, and of small size."†

Dr. Bartlett speaks of the mucous membrane as presenting ulcerations in about one third of the cases, and that they were present in

* Bartlett. Treatise on Fevers, p. 93.

† Researches on Typhoid Fever, vol. i. p. 376.

twenty-three of seventy-four examinations made by Louis and Barth. He says that they occupied most frequently the cœcum, though they were not confined to that portion of the intestine. In a small number of instances the submucous cellular substance of the isolated follicles were found to have undergone the same yellowish transformation that has already been spoken of as occurring in the elliptical plates of the small intestine.*

Although the large intestine has been found less frequently the subject of disease than the small intestine, still its *post-mortem* phenomena are, in our opinion, of too frequent occurrence and of too decided a character, to be regarded as altogether secondary, and in our analysis it will be our object to show that these, like many other of the pathological conditions presented by the various organs, are not more of a secondary nature than are the changes of the elliptical plates of the ileum themselves, and, like these changes, are the direct result of causes common to both. Which causes, in our opinion, are identical with the ultimate pathological condition upon which all the phenomena, both symptomatic and anatomical, depend. To the investigation of their nature and influence we will presently turn our attention.

The lymphatic ganglia of the mesentery are very generally found in a diseased condition, and the amount of disease which they evince seems to correspond with the condition of the elliptical plates of the ileum, though this is not invariable, for those found between the two layers of the mesocolon are often found in the same diseased condition. The changes consist generally in enlargement, softening, and alteration of colour—red, bluish or gray—and in the deposition of purulent matter in their interior, marked by small yellow points.

In the course of the foregoing summary we have very constantly kept in view the differences between the two types of continued fever, although not with that order and regularity which would be necessary in a systematic treatise on the two diseases. It was only important to notice these differences, as they were suggested by the description of the symptoms of the typhoid type. Farther, it will have been observed that in our description of the symptoms occurring under the head of disturbances of the digestive organs, as well as in the account of their pathological lesions, we have instituted no comparison between the two types. The reason of this omission has been, that in the typhus type, none of the symptoms during life, or

* Treatise on Fevers, p. 100.

the *post-mortem* appearances, pertaining to these organs, seemed to have any important connection with the characteristic phenomena of the disease, there being neither *diarrhœa* nor important intestinal lesion reported with any degree of uniformity in the typhus type;* and, moreover, of late years the basis of distinction between the two types has been the existence or non-existence of disease in the intestinal canal; as will be observed in the admirable Treatise of Professor William Jenner, of London, on the Identity or Non-identity of Typhoid and Typhus Fevers.

The object of the present treatise being to arrive at what we consider the true, or, at least, the most rational theory of the typhoid affection, by an analysis of some of the most prominent phenomena in its natural history, an extended review of the many doctrines now in existence in relation to its pathology, would be inappropriate. Suggestions regarding the proximate cause of typhoid fever, will, we fear, meet no great degree of favour, for there is no disease in relation to which so many theories have been promulgated. The peculiar condition of the blood, the cerebro-spinal system, and the various abdominal viscera, have been each referred to as the pathological domain of this mysterious disease; yet neither, it appears to us, is alone adequate to the entire explanation of all its phenomena.

If we refer it to the state of the blood, and argue on the one hand that the continuously rapid and feeble pulse, the pale and softened condition of the heart's substance, the slight cutaneous eruption, the obstinate passive diarrhœa, the pain and tympanites, the congestion, stasis, and hemorrhages in the intestinal mucous membrane, as well as the changes and ulcerations in the elliptical plates, found in typhoid fever; and, on the other hand, that the still more rapid pulse, more softened condition of the heart's substance, together with the stasis and hemorrhagic spots (petechiæ), found on the cutaneous surface, are all the common result of these changes in the blood, and of these changes *alone;* and if we farther admit, with Andral and Gavarret, that these changes consist mainly in hypinosis, we must at the same time, admit that the theory is embarrassed by a great fallacy, viz. that the blood is often in the very opposite state, hyperinosis, for a considerable time during the course of the attack,

* Spontaneous diarrhœa is as *rare* a symptom in typhus as it is a common one in *typhoid* fever.—Bartlett, p. 216. Amongst Dr. Gerhard's cases: "In the entire number of autopsies there was but a single case, and that of doubtful diagnosis, in which the slightest deviation existed from the natural appearance of the glands of Peyer." —*Ibid.* p. 233.

and yet no corresponding change in the symptoms is manifested. And farther, could we reconcile this, we would still find it difficult, without admitting the influence of other causes, to account for the production of such very dissimilar results in the two types; the principal manifestation of disease being in a *mucous* membrane in typhoid fever, and in the *skin* in typhus fever.

In relation to the cerebro-spinal system, for reasons sufficiently obvious, we would find it impossible to explain all the phenomena of the disease by here locating its proximate cause; for neither is the character of these phenomena taken as a whole, such as would be recognized as resulting from disease in the cerebro-spinal axis, nor is the correspondence between the severity of those symptoms which are plainly referable to this system, and the gravity of the more characteristic symptoms of the disease sufficiently close to authorize such a conclusion.

A very natural, and on a cursory view, almost inevitable theory, in regard to the pathology of typhoid fever, is that it must be either solely dependent upon, or very closely connected with, that invariable, and generally very serious amount of disease in the lower portion of the small intestine. This lesion, it cannot be denied, presents a greater amount of correspondence between its actual extent and the severity of the general essential symptoms of the disease, than any other set of phenomena connected with it. Louis, if he does not entertain this theory of the pathology of typhoid fever himself, has certainly, in his admirable statistical researches, afforded the strongest corroboration to others for their belief, and is often found expressing himself in a manner very favourable to this doctrine. "Notwithstanding," says he, "the small number of complications, and the comparative importance of each one of them, the symptoms were the same as in a great number of cases, in which the secondary lesions were much more grave; and this with other nearly similar facts, shows that almost all the symptoms observed in typhus fever, and *especially those which may be called characteristic, depend on the peculiar morbid changes in the ileum.*"* And again: "We must conclude *that the time*, at which the *alteration of the elliptical patches of the ileum commenced, was the same as that of the disease;* and we must not consider this lesion as one of the effects of the fever, but that it forms the anatomical characteristic of it."†

* Researches on Typhoid Fever, vol. i. p. 82.

† Ibid. vol. i. p. 92. It is with great reluctance that we attempt an interpretation of Louis's doctrine as favouring the opinion, that the above changes are the proxi-

From the above it would appear, at the very least, that Louis regarded this lesion as one of the greatest etiological importance. But when we give all the facts in connection with the abdominal lesions a more careful consideration, we must find that it is impossible to account for all the "characteristic symptoms" of the disease, by locating its ultimate pathology in this region, for although there is a more regular correspondence between the lesions and the symptoms, here than elsewhere, still, to attribute the symptoms *entirely* to this local lesion, appears unreasonable, when we reflect that in *typhus* fever, a disease at least *similar* and even by many considered *identical*, there is, as the rule, no trace of such a lesion, no trace of the diarrhœa, or of the pain and the meteorism resulting therefrom. Under this view, one of two positions must be assumed, either that those symptoms, which the two types possess in common, and which endow them with the typhoidal aspect, are due to conditions of the organism which have no analogy in the two diseases, and that typhoid and typhus fever are two distinct diseases. For if the characteristic symptoms arise solely from the intestinal alterations in typhoid fever, as these alterations do not exist in typhus, those symptoms must have their cause elsewhere. Now it would be very surprising if two sets of symptoms, so exactly simulating each other, that the most skilful and experienced have denied the least difference between them, should arise from entirely different causes, the one depending upon intestinal follicular disease, the other upon some as yet unknown cause. Certainly, such a conclusion would not be very philosophical. This theory, then, like the others, requires to be presented in no other light than the above, to show its inadequacy to the explanation of the phenomena of the typhoid form of fever.

It may be asked, what theory then can be advanced, to which so many rational objections will not be urged? We candidly answer *none;* but in our opinion, in the adoption of a theory of this disease, we should consider that most stable and philosophic, which, while it is as competent as any of the foregoing to the explanation of all the phenomena of the *typhoid* type of fever, yet, presents nothing which would exclude altogether from the same order of diseases, its

mate cause of typhoid fever; the more especially, as Dr. Bartlett, than whom no one in this country, in our opinion, is better qualified to do full justice to this great pathologist, has expressed his unbelief that such was his opinion. We may be mistaken in our interpretation of his expressions, and, therefore, have not charged the doctrine upon him, and have only remarked that he appears to have favoured it very decidedly in the above-named places.

unmistakable counterpart—its archetype, typhus fever. For, it is undeniable, that these two diseases are inseparably bound together, in ties of the strongest and most indissoluble, though mysterious, affinity, and the necessity which any theory may involve, of separating them, is enough, of itself, to declare its absurdity.

The view which we have taken in relation to the proximate cause of typhoid fever, is, we are fully aware, liable to many objections, but after a careful consideration of it, in all its bearings and dependencies, we can but regard it as perhaps less obnoxious to fallacy than most of its contemporaries. "Pathology," remark Todd and Bowman,* "is the physiology of disease; and it is obvious that no pathological doctrines can command confidence, which are not founded upon accurate views of the natural functions," it is equally necessary, we would add, that these views be *comprehensive* as well as accurate, for without due importance being accorded to *relative* physiology, we mean that important bearing and relation which the functions of one portion of the organism has to those of another in health, and more especially in a state of disease, we are apt to lose sight of all just reasoning and legitimate induction, and to pursue but the waifs and shadows of a most uncertain and devious philosophy.

We have seen by only a cursory view, that neither the humoral or sanguineous theory, nor the intestinal, nor yet, again, the cerebro-spinal or nervous theory of typhoid fever, will account satisfactorily for all its phenomena; we must, therefore, look elsewhere for an explanation of them. After the most careful and laborious consideration of the phenomena, relationships, and events of this truly mysterious disease, keeping in view, at the same time, as well as we were able, the *entire* physiological dependencies of such an intricate question, we are induced to regard the typhoidal state, manifested both in typhoid and typhus fevers, as a morbid affection of the whole or portions of the ganglionic system of nerves, known also as the great sympathetic nerve, but of the exact nature of which, and how produced, we know not. In the succeeding analysis, it will be our object to show that the characteristic typhoid phenomena are found to occur in a more marked degree, in those portions of the organism which are admitted to be, and in most cases can be demonstrated as being under the control of the sympathetic ganglia and their various nerves, and that the occurrence of other phenomena is

*Physiological Anatomy, p. 28, London edition. "It is also certain that improvements in pathology must follow in the wake of advancing physiology."—*Ibid.*

the result of relations, more or less direct, with this important system of nerves. In the course of our examination, we shall endeavour to show that both anatomy and the most approved physiological doctrine of the present day, are, in a great measure, confirmatory of our position, and farther that it will be corroborated by the recorded experiments of this and the past century.

We are aware that referring the pathology of disease to the sympathetic system of nerves, though not without precedents of the most respectable and even revered character,* is still at the present day somewhat unusual, and while, in the confidence of an honest, and if not enlightened, we can at least say, a *studied*, conviction, we argue the justness of this pathology, we would ask in the first place, that indulgence which the defects of our performance must necessarily need, and in the second, a full acquittal from the arrogance which we are aware is more than apt to be imputed to him, who would deny established, and substitute new doctrines in pathology.

In view of the neglect, of which, at least in this country, the nervous system, and especially this portion of it, is the subject, we would be unwilling to enter into our analysis without referring briefly, by way of refreshing the memory, to some of the most important features in the anatomy and physiology of the ganglionic system of nerves. In so doing, we will not embarrass our description with a discussion of the many theories in regard to its functions, but will give that which we have adopted ourselves as most rational, and which, fortunately for us, we are able to say is that most universally admitted by the best physiologists of the present day, and which vivisection, that best of all tests, has most plainly, and, to our mind, incontestably demonstrated.

The Sympathetic Nerve. Its Anatomy.—In this description, we shall give the views of the various authors within our reach who coincide with us in relation to the function of this nerve, using very much the same order of description, and also, when its terseness and comprehensiveness will admit, their language.

Under the title of the sympathetic nerve, say Todd and Bowman,† is comprehended a great subdivision of the nervous system, which presents certain peculiarities of structure and of distribution, whereby it is strikingly contrasted with the strictly cerebro-spinal nerves.

* Lobstein, Structure, Functions, and Diseases of the Human Sympathetic Nerve.

† Physiological Anatomy, Chap. xxi.

It consists of an uninterrupted chain of ganglia, extending on each side of the vertebral column from the first cervical vertebra down to the coccyx, and moreover extending upwards beside the cranial vertebræ, and occupying spaces between the bones of the cranium and those of the face. The continuity of this chain is preserved by cords of communication which pass from one ganglion to another; the chains of opposite sides communicate with each other, at various parts, in the plexuses of nerves which originate from them. The ganglia are sometimes divided for convenience of study into cranial, cervical, dorsal, lumbar, and sacral, each of these regions, containing a number generally corresponding to the number of the vertebræ in each. From each portion, certain sets of nerves may be traced; these are, omitting the cords of communication between the ganglia—1st. *Visceral* nerves, which generally accompany branches of neighbouring arteries to the viscera; 2d. *Arterial* nerves, apparently devoted to arteries in the vicinity of the ganglia; 3d. Nerves of communication with the cerebral or spinal nerves, which emerge from the cranium or spine, near the ganglia. The visceral and arterial branches have a remarkable tendency to form intricate plexuses, which entwine around the bloodvessels, and the visceral branches are conducted by these vessels into the tissue of the viscera. Of the branches of communication, it is sufficient to say, that they connect the ganglia with the cerebro-spinal system of nerves by means of two different sets of fibres, which are called its white and gray roots. The gray root appears to connect the ganglia of the sympathetic nerve to the ganglia on the posterior root of the spinal nerve, while the white root appears to be a branch coming from the spinal nerve, and to receive an equal amount of fibres from its anterior and posterior roots. These fibres may be seen in every instance spreading out upon the adjacent sympathetic ganglion, passing through the vesicular matter of which it is composed, and following the course of the trunk of the sympathetic for a longer or shorter way, and then proceeding from it in connection with the gelatinous fibres chiefly, to supply the viscera. These fibres are regarded as branches of the spinal nerve, which are distributed in connection with the gelatinous fibres, which are considered the true and proper sympathetic fibres, and are derived from the ganglia. Carpenter* speaks of the cerebro-spinal fibres passing into the sympathetic, and the sympathetic fibres passing into the

* Principles of Human Physiology, p. 558, ed. 1853.

cerebro-spinal nerves at their roots. From the above, it would appear then that the sympathetic system consists in its intimate structure of two distinct kinds of fibres, viz. those which come from the spinal system of nerves and also of the true sympathetic fibres, which are called gelatinous, and are peculiar to this system, and which originate from the vesicular matter of the ganglia.

Thus constituted, the sympathetic system is found located as above described, in the various parts of the organism. In the head, four or five ganglia which are connected together by filaments; these are the ophthalmic ganglion which is situated in the orbit on the outer side of the optic nerve; from this ganglion which is in close connection with the third or motor nerve of the eye and also with the nasal branch of the fifth nerve, a sensory nerve, proceed various branches of distribution to the eyeball, under the name of ciliary nerves. This ganglion has a third root by which it is brought into connection with the superior cervical ganglion.

The other ganglia are the spheno-palatine, situated in the pterygo-maxillary fossa; like the lenticular ganglion, and indeed like every other sympathetic ganglion wherever found, it is connected with a cerebro-spinal nerve, viz. the superior maxillary or second division of the fifth pair, a sensory nerve, by two small branches, which join it from above. This ganglion distributes branches in a great variety of directions, but those which we describe as most nearly connected with our subject, are the *three palatines*, anterior, middle, and posterior — to the *mucous* membrane of the *hard and soft palate*, uvula, and to the *nasal mucous membrane;* the *spheno-palatine*—to the mucous membrane of the spongy bones and that of the septum. Also the Vidian or pterygoid branch, one branch of which enters the cranium and connects itself with a swelling on the portio dura, and another becomes a part of a plexus which surrounds the carotid artery, and finally is connected with the superior cervical ganglion.

The *Otic* ganglion is situated on the inner border of the foramen ovale near the inferior maxillary nerve. It is very plainly a sympathetic ganglion as shown by its structure, for in this we find the vesicles as well as the tubular and gelatinous fibres very distinct; indeed, it is often selected as a specimen for the microscope on this account. This ganglion is connected with the third division of the fifth nerve, which nerve is both *sensory* and motor in its function. This ganglion gives off various branches, some of which supply the cavity of the tympanum. It has also another branch which connects

it with the glosso-pharyngeal, which is distributed to the glands, follicles, and mucous membrane of the tongue. The last one of the cranial ganglia which we will describe is the *submaxillary*, situated in the substance of the submaxillary gland; it is connected with the gustatory branch of the fifth nerve, a nerve of special sensation, and its branches are distributed to the submaxillary and sublingual glands and their ducts.

The *Cervical Ganglia* are three in number, called superior, middle, and inferior. The superior, situated at the upper part of the cervical portion of the column, is connected by large branches with the first, second, and third spinal nerves. It sends branches up into the carotid canal, which divide and subdivide in such a manner as to form a complete plexus around the artery, which is called the carotid or cavernous plexus. With this plexus, there are numerous communications; one which we particularly mention, which goes to assist in forming the *tympanic* plexus; so here again it will be perceived that the internal auditory apparatus receives a supply of sympathetic filaments. Branches also accompany the various ramifications of the internal carotid artery in its distribution within the cranium. Communications exist between the various parts of the eighth and ninth pairs and this ganglion, and also a large trunk connects it with the middle cervical ganglion. Its visceral and arterial branches are those which supply the *pharynx* by forming the *pharyngeal plexus* with the branches of the glosso-pharyngeal and vagus; also a few filaments to the larynx accompanying the laryngeal branch of the vagus. The most important branches from the second and third cervical ganglia are those large branches which, together with a smaller and more variable branch from the superior ganglion, serve to supply the *heart, principally*, with its innervation, under the name of superior, middle, and inferior cardiac nerves, which form plexuses under the name of cardiac, for the supply of this organ and of the *aorta*, some of them going to assist in forming the pulmonary plexus to supply the lungs.

The thoracic portion of the sympathetic system consists of a series of ganglia corresponding very nearly with the number of the vertebræ; these communicate freely with each other and also *with the roots of the spinal* nerves. They send branches to supply the aorta, which form the aortic plexus, and serve to constitute several large branches called the greater and lesser splanchnic nerves; they pierce the diaphragm, the former joining the great semilunar ganglion, and the latter the renal and aortic plexuses. The *lumbar and sacral*

portions of the sympathetic are connected with the dorsal or thoracic portion, sometimes by a small intercommunicating cord between the last dorsal and first lumbar ganglion and sometimes by the lesser splanchnic nerve. They, like the above, have numerous and very distinct communications with spinal nerves, and form plexuses for the supply of some of the abdominal and of the pelvic viscera, together with the lower portion of the aorta under the name of inferior aortic plexus.

In addition to the above ganglia, which are usually denominated, from their location and close connection with the general nervous system, the spinal or vertebral sympathetic ganglia, there are others of not less, and by some authors considered of infinitely more importance; we refer to the *isolated* ganglia, situated within the thoracic and abdominal cavities, and which appear to have comparatively but little direct and intimate connection with the cerebro-spinal system or with the external parts of the organism, and to be devoted to the viscera entirely, and therefore are with their branches pre-eminently entitled to the denomination of *visceral ganglia* and *nerves*. These are found in various situations, several of them in connection with the various cardiac plexuses,* but the most important are found in the abdominal cavity forming the centres of the solar plexus, under the names of greater and lesser semilunar ganglia; from these pass off plexuses accompanying and corresponding in name with the various branches and sub-branches of the cœliac axis, and conducted by them into the organs, for which they are manifestly intended. Todd and Bowman thus describe these plexuses: "The nervous plexuses of the abdomen are extremely complicated and numerous. They are principally derived from two great ganglia, situated, one on either side of the cœliac axis, in front of the aorta. These ganglia are semilunar in shape, convex downwards and outwards; they unite below the cœliac axis; and chiefly from the convex border, a vast radiation of plexiform nerves takes place, which follow the course of and entwine around the branches of the cœliac axis, and other branches of the aorta. To this great radiator, anatomists have given the name of *solar plexus*, and the conjoined semilunar ganglia must be looked upon as the great centre—the *sun* of the abdominal sympathetic system."

* Several ganglia are found in connection with the nerves of the heart. Wrisberg describes one near the arch of the aorta, and Remak describes and figures several among the anterior and posterior cardiac plexuses, and in the substance of the heart.—*Todd and Bowman*, p. 505.

From this solar plexus proceed subdivisions or smaller plexuses, corresponding with the arterial trunks in this region, as the diaphragmatic plexus, a small network accompanying the phrenic arteries, and the supra-renal arteries. 2d. The coronary or gastric plexus, which assist with the pneumogastric nerve in the supply of the stomach. "Of these filaments," says Cruveilhier, "some ramify upon the *cardia*, while the remainder follow the coronary artery along the lesser curvature of the stomach. *It follows, therefore, that the stomach is principally supplied by the pneumogastric nerve. The cardia and the lesser curvature of the stomach are the parts which are the most abundantly supplied with nerves.* The pylorus, to which we attribute such great sensibility, has incomparably fewer nerves."* To the liver there are sent, in great profusion, branches, from this great plexus, which constitute the *hepatic plexus*, the branches following the course of the arteries, and being conducted by them into every portion of the intimate tissue of the organ. For the spleen there is the splenic plexus, and so likewise the renal plexus for the kidneys; though this last, together with the inferior mesenteric and spermatic plexuses, are not so directly offsets from the solar plexus, being more distinct from it than those above described.

Lastly, as most intimately connected with our subject, we describe more fully the *superior mesenteric plexus*, which supplies the greater portion of the intestinal canal, accompanying the ramifications of the superior mesenteric artery to wherever these are distributed. Finding the most concise, and, at the same time, most pertinent description of this plexus in Cruveilhier's Anatomy, we prefer to use his words: "The superior mesenteric plexus, which may be regarded as the lower division of the bifurcation of the epigastric plexus, is the largest of all the abdominal plexuses; it surrounds the superior mesenteric artery, forming an extremely thick plexiform sheath for it; it passes below the pancreas, enters the substance of the mesentery with the artery, and divides, like that vessel, into a great number of secondary plexuses, which are distributed to all parts supplied by the artery, namely, the *whole* of the *small* intestines, *excepting the duodenum*,† and right portion of the great intestine.

One more point in relation to the anatomy of the nervous system in reference to this subject, and we have done; we refer to the very

* Treatise on Human Anatomy, p. 867, and marginal note.

† Dr. Todd, in the Cyclopædia of Anatomy and Physiology, says that the duodenum is supplied by the cerebro-spinal system of nerves.

close connection that exists between the ganglionic system, and the pneumogastric or par vagum nerve; both in the substance of the lungs and in the superior cervical ganglion,* as well as in its relations to the semilunar ganglion, so close is this latter connection, that some authors have even regarded the whole nerve as originating from this ganglion,† a surmise which, we must admit, is altogether unfounded; but still, it serves to show the character of this connection, as well as in some measure the character of function attributed to this nerve.‡ Dr. John Bird, in his experiments on the nerve, found that its section produced, besides other symptoms, a peculiar congestion of the lungs, *resembling* pneumonia, which congestion was, no doubt, attributable to the cutting off from the lungs the supply from the sympathetic system. This, then, brings us to a consideration of the *functions of the sympathetic system.*

In the physiology of the nervous system, if there is one fact better established than another, it is, that the ganglionic system, whatever else may be its functions, presides over and controls the important act of circulation, secretion, and nutrition; or, at least, forms a necessary element in these functions. Anatomy, both special and transcendental, as well as vivisections and physiological experiments, all serve plainly and incontestably to demonstrate this fact in relation to its office. "Clinging to the coats of the arteries, it follows them, for the most part, in their ramifications, and attaches itself to them, as the ivy does to a tree." It seems to be nerve of the bloodvessels, and as, remark Todd and Bowman, "secretion is mainly dependent on the normal nutrition of glands, it is reasonable to suppose that that function would be, to a certain extent, controlled by these nerves." Dr. T. B. Proctor, in a very sensible treatise on the sympathetic nerve, says: "It is quite clear, from the important and interesting experiments made by Wilson Philip, Legallois, and Fleurens,

* Todd & Bowman, pp. 488 and 502, Physiological Anatomy, American edition.

† "I am perfectly aware," says Dr. James George Davey, of London, "that Dr. Stevens maintains both the vagus and spinal accessory nerves derive their origins not from the medullæ oblongata, *but from the upper part of the semilunar ganglion.* But I cannot think so."—*Vide* Ganglionic System, *London Lancet*, vol. for 1851.

‡ This nerve, from the resemblance in its functions to the sympathetic, has been called the lesser sympathetic nerve, and it is remarkable that, in that class of animals in which the sympathetic is said to be deficient, or nearly so, its place is supplied by the pneumogastric.

"In the cyclostomes among fishes," says Wagner, "the sympathetic is either wholly or in major part, replaced by the par vagum; the same thing occurs among serpents." —*Elements of Special Physiology*, p. 514.

that neither the brain nor nerves of the spine have anything to do with the circulation of the blood; as it could be seen that animals lived for some time, and the circulation went on with vigor, after the brain and spine had been removed, separately, and also conjointly. It is self-evident, then, that it is *to the sympathetic (and to that alone) that we must look as the regulator of the arterial system.* And it will be observed that, in all parts of the animal body where large and sudden supplies of blood are required, such as the heart, stomach, bowels, and organs of generation, we have the sympathetic or ganglionic system very fully developed, and as far as I can judge, in ratio to the amount of blood supplied to these several organs. On the contrary, in some parts of the body, and in the extremities, where the flow of blood is more regular, and not subjected to those sudden calls for large supplies of blood at irregular periods, we find this nerve manifestly decreasing in size; and, indeed, as far as we can judge with the naked eye, ceasing altogether in some parts. Still, I perfectly agree with Sir Charles Bell, *that it is distributed all over the body;* but whether its influence is confined to regulating the small vessels which supply the coats of the arteries, or whether the same influence is continued by it over the whole circulating medium of the extremities and other parts that it manifestly exerts over the abdominal viscera, must, I fear, be left to a more enlarged inquiry."* Dr. Carpenter, who believes somewhat differently from the above, and, with most physiologists of the present day, namely; that the sympathetic nerve derives whatever of sensory and motor power it possesses from the anterior and posterior column of the spinal cord, expresses himself in the following apposite manner in regard to the functions of the sympathetic as a whole. "It seems fair to conclude that the motor power of the sympathetic system—which is chiefly exercised on the *muscular substance of the heart* and *walls* of the bloodvessels, on the *muscular coats of the alimentary canal*, and of the large gland-ducts which open into it, and on the muscular walls of the genito-urinary organs—is entirely derived from the cerebro-spinal system. In no instance, however, can the will† exert any in-

* Medico-Chirurgical Review, Jan. 1845, also Treatise, separate, p. 21.

† We do not wish to deny this assertion; but there is on record one familiar case, which would appear at first sight strongly contradictory of this statement, that of Col. Townsend, who is said to have had such entire control over the action of his heart that he could make it cease to beat at any time, and virtually die, and live again, so far as the circulation was concerned, at will; but, on one occasion, having

fluence over the movements of these parts; they are strongly affected by emotional states of the mind, and they frequently seem to respond to impressions made on remote organs. If, then, the sensori-motor endowments of the sympathetic trunks be restricted to those fibres which are really cerebro-spinal in their origin or termination, it remains to inquire what are the functions of the *true* sympathetic fibres, whose vesicular centres lie in the ganglia of the sympathetic system. Upon this point, we can only surmise; but there appears strong grounds for the conclusion, *that the office of these fibres is to produce a direct influence upon the chemico-vital processes concerned* in the *organic functions* of *nutrition*, *secretion*, &c.; an influence which, although not essential to the performance of each separate act, may yet be required to harmonize them all together, and to bring them into connection with mental states."*

Sir Charles Bell's† opinion is somewhat similar. "We are left to the conjecture that the sympathetic or ganglionic system of nerves, according to Bichat, are for those thousand secret operations of a living body, which may be called constitutional: *circulation*, *secretion*, and *absorption*, are operations which simultaneously affect the entire frame."

From the above, then, it appears that the sympathetic system, as a whole, being composed of intrinsic gelatinous fibres and cerebro-spinal or tubular fibres, has two distinct and separate offices to perform in the animal economy, viz. 1st, by virtue of its cerebro-spinal or tubular fibres, to preside over the movements and sensations (what little they possess) of the *heart* and other involuntary muscles, as the muscular coats of the *intestines*, *bladder*, *and the coats of the various excretory ducts; and that it is the source of intrinsic motory power to the bloodvessels, these depending upon this system for their innervation;* and, secondly, that by its vesicular and gelatinous portions, it presides over the chemico-vital operations of the animal organism,

willed himself to death for the amusement of some friend, he carried the experiment too far, and life became extinct.

This peculiarity was probably due to an unusually large supply of filaments from the pneumogastric and spinal nerves, as is very frequently observed in dissections, or as we would now suggest, it was attributable to disease of those fibres of the sympathetic which belong essentially to it, and of the ganglia, by which disease those parts had lost their *isolating power*, so that the cerebro-spinal influence, over which the *will* presides, was transmitted unembarrassed to the heart. This case certainly should not detract from the force of Dr. Carpenter's remarks.

* Principles of Human Physiology, 1853, p. 830, *et seq.*

† On the Nerves, p. 11.

concerned in *digestion*, *secretion*, *absorption*, &c. &c. In a few words, then, it presides over the functions of all the involuntary muscles, and controls circulation and secretion.

PATHOLOGICAL DEDUCTIONS.

Having thus carefully recounted the more important features in the anatomy and physiology of the sympathetic system, it remains but to consider them in connection with the phenomena of typhoidal fevers. Such a review will be attended with the following results. In the first place, the essential symptoms of typhoid fever are located in organs deriving their innervation principally, and in many instances, entirely from the ganglionic system: In the organic or involuntary muscles—as for instance the *heart's*—of which, during life, we find the frequency increased, the force diminished, and the regularity impaired—all of which effects must be plainly attributable to the *altered innervation* of the organ. After death, we have seen it the subject of very material alteration; its substance is flabby, pale, and much softened, so that it breaks readily under the fingers. Instance again, the *muscular coat* of the intestine; we have *meteorism*—an almost invariable symptom in typhoid fever—and which we may legitimately refer to the loss of *tonicity* in the muscular coat of the intestinal canal, from impaired innervation of that coat, by which condition, together with the altered state of the secretory surfaces, the passive accumulation of gas in the intestines is allowed, and hence the tympanites.

That this altered condition in the innervation of the organic muscular fibre does exist, is shown most remarkably in the mode of dying in some cases, viz., that mode termed *asthenia*, "occasioned by causes acting directly on the circulatory forces, affecting the *vis nervosa*, upon which the contractile property of the heart depends,"* and farther, that this depression in the involuntary muscles has no invariable correspondence in the state of the voluntary muscular system; as we shall find remarkably illustrated in the observations of Dr. Flint.† "In some of the cases attended with most danger, and some of them ending fatally, the *muscular strength was retained in a surprising degree.* In two fatal cases of the typhoid type, characterized by active persistent delirium, the muscular efforts were almost constant and quite strong up to a few hours before death. One of these cases

* Flint, p. 125.

† Reports on Continued Fever, p. 59.

terminated on the ninth day, and the other on the third day after coming under observation. The mode of dying in each was by *asthenia*, or, perhaps, more properly, *necrœmia; the system of involuntary muscles exhibiting reduction of force to a degree incompatible with life—the voluntary muscles remaining active.* This is a curious fact."

This relative condition of the voluntary and organic muscular systems, appears to impress even the observing and philosophic mind of Dr. Flint as almost inexplicable; and it is not surprising that it should, when we consider that his views of the pathology of typhoid fever have no fixed or definite reference to the organic system of nerves; but, on the admission of the ganglionic pathology of the disease, the full interpretation of these phenomena, besides many other similar facts (meteorism) before inexplicable, become easy and natural.

II. Besides the organic muscular system, which we have just shown to be under the influence of ganglionic nervous aberration, we find that the other characteristic phenomena of typhoid fever refer to the functions of nutrition and secretion, both of which important processes depend upon the vascular system, which, especially in the viscera, are admitted to be under the sole dominion of the sympathetic nerve. And, what is more remarkably illustrative of this fact, is, that there appears to be a very close relation between the amount of disease observed in any particular portion of the organism —the alimentary canal for instance—and the degree to which it is indebted to the ganglionic system for its innervation; thus we find but a small amount of disease, congestion, seldom any ulceration, in the *larynx;* ulceration is somewhat more common in the pharynx, œsophagus, and stomach, though still not abundant. It disappears in the *duodenum*, which receives but few sympathetic filaments, and again appears in the upper portion of the *ileum*, increasing, as we descend, *in direct proportion* to the amount of ganglionic fibres the part receives, till it reaches its maximum in the lower portion, where the nervous supply is very abundant; after which, we find ulceration *occasionally* in the cœcum, still less frequent in the colon, till in the *rectum*, whose innervation is principally from the cerebro-spinal system, it is never observed. So, likewise, with regard to the other organs; we find the *liver*, *lungs*, and *spleen* are all subject to congestions, which can be referred to the same abnormal innervation of these viscera.

From the relative unfrequency of disease in certain portions of

the abdominal viscera, and elsewhere, Louis, as we have seen, though admitting their diagnostic importance, is disposed to view them as results, secondary to the lesion in the ileum; we cannot, however, agree with him, but are compelled to regard them as the *common primary results* of a *common cause* which exists in the ganglionic system, and that the frequency or the gravity of disease in any one of these organs is determined alone by the amount to which the *ganglionic ingredient* mixes with, or enters into its innervation, and that disease in these localities has no etiological reference whatever to that in the ileum; but, when it exists, is as significant of the true pathology as is the ileitis—for it invariably indicates, both by its location and character, that its origin is *abnormal innervation.*

So far then as regards the *localities* in which the manifestations of typhoid fever occur, we have found an exact correspondence with the distribution of the sympathetic nerve, as likewise between the *amount* of disease and the proportion of this kind of innervation in any given parts. Now it will be our object to examine carefully, in order to ascertain if there is any analogy between the *character* of these typhoidal phenomena, and of those results which have been obtained by experiment upon this system of nerves. In this interesting department of physiological inquiry, there have been many engaged, but a few will answer very well the purposes of our comparison. As early as the year 1732, Pomfour du Petit found that the *division* of the trunk of the sympathetic, opposite the fourth or fifth cervical vertebra in dogs, was very rapidly followed by great disturbance in the circulation of the eyeball, producing inflammation, flattening of the cornea, retraction of the eyeball, with protrusion of a fold of the conjunctiva and a *flow of tears*, and ultimately ulceration and destruction of the organ. The experiments of Dupuy upon horses, wherein he *extirpated* the superior cervical ganglion, were followed by the same results with regard to the local effect in the eye, but also, with the more opposite and corroborative consequences, that there was *an eruption over the whole cutaneous surface*, with emaciation and an œdematous state of the limbs. Dr. John Reid, has also experimented on the sympathetic nerve in the neck, and found the eye similarly affected with the above, the *conjunctiva becoming red* and *congested* in a few minutes, while in other experiments* the eye presented an *ecchymosed* or *bloodshotten appearance.* Each one of these conditions of the eye must be borne in mind, in

* Arneman's Experiments on Nerves. Gottingen, 1787.

order to appreciate the comparison; inasmuch as, on account of the great difficulty of making such experiments on other portions of the sympathetic system, we can find none on record which will serve as reference; for it will readily appear that, from the remote position of these nerves, it is impossible to make their section without so materially deranging other important parts of the organism as to render the results valueless in deduction.

Now, a reference to some of the pathological phenomena of typhoid fever, will discover a close analogy, if not identity to the above results; in the first place, the conjunctival congestion; its character, the attendant suffusion, together with the entire freedom from pain, even on exposure to the strongest light; while, at the same time none of the symptoms of true inflammation are present; all indicate the seat of the nervous derangement upon which it depends to be the ganglionic system* and not the cerebro-spinal, the analogous derangements of which are invariably of a sthenic character, and attended with acute pain in the region in which they occur. Again, an attentive consideration of the character of these congestions will show that it does not vary in any respect, except in degree, whether occurring in the mucous membrane of the eye, that of the stomach, pharynx, small intestine, large intestine, or bladder, in the typhoid type, or on the cutaneous surface in the typhus. In all the above localities, and under all circumstances, we find the capillary congestions wearing the same aspect, assuming invariably a *passive* character, often approaching the condition of true stasis, but never attended with the florid redness, the pain or the swelling of active inflammation. Lastly, in the cutaneous petechial eruptions or maculæ of the typhous type of continued fever, we can also detect the same character of *passive congestion* from deficiency of nervous energy carried to a still greater degree; in this type, the nervous power of the cutaneous capillaries is so far diminished, that it amounts to a state of actual paralysis, allowing such distension of the capillaries that their rupture and a subcutaneous effusion is the result.

We have thus far endeavoured to show that typhoidal fevers result from alterations in the condition of the ganglionic nervous system; first, by comparing the typhoid phenomena with the normal action

* Dr. A. Billing remarks, in relation to this subject: "Without, therefore, at present seeking for farther proofs, I deduce from blushing, and from the effects of electricity, fire, and cantharides, that the capillaries are dependent upon the nervous system for that tone or energy which preserves them from over-distension."—*The First Principles of Medicine*, p. 44.

of the sympathetic system, and we have found that the analogy is complete, and that typhoid phenomena are but the result of aberrations in the normal action of these nerves. Their action may be either exaggerated or diminished; for instance, a portion of this system controls the action of the heart, and in health endows this organ with a frequency of action amounting to 60 beats per minute in the adult; and without disturbing causes, this number will continue unvaryingly in its regularity till the close of life. But we know that this regularity is liable to many interruptions and disturbances; some of them but momentary, as from the emotions; others disturb it for many hours by increasing its frequency, as in paroxysmal fever; and lastly, in typhoid fever, we find this increase of frequency kept up for many weeks, but still retaining the remarkable feature of continuousness, which distinguishes the normal action of the sympathetic system from that of the cerebro-spinal system, which is intermittent in all its phenomena, whether normal or abnormal. Were we now requested to explain the difference which marks the increased frequency of pulse in these three instances; to answer why is it evanescent in one case; of but a few hours' duration in the second; and yet continue many weeks in the case of typhoid fever?—we think, we should do it thus: The heart, being under the dominion of the ganglionic system, performs its normal action through its influence; but from the intimate connection between the sympathetic and cerebro-spinal systems, especially in this organ, it is very liable to be affected by emotional causes acting in the brain; these, of course, will be evanescent; or it may be affected by causes acting in the spinal marrow, which may be more durable, as would be the case in a paroxysm of intermittent fever;* but it will be observed that, in these cases, the organic system is only secondarily implicated, and so soon as the mental emotion subsides, or the spinal irritation is removed or has exhausted itself in a paroxysm, the excitor being withdrawn, the sympathetic becomes again normal, and the action of the heart consequently natural. But in continued fever, the case is quite different; the irritation is now located in the ganglionic centre itself, which supplies the heart, and consequently the increased frequency

* We have adopted the pathology of intermittent fever advocated by Maillot, viz. that it consists in cerebro-spinal intermittent irritations. Prof. J. F. Lobstein remarks: "The paroxysms of intermittent fever are tied down to a regular rhythmus, in consequence of being radicated in the nervous system, upon which nature has impressed a law according to which they must perform their functions periodically.—*Sympathetic Nerve*, p. 121.

continues as long as this irritation remains, which is coeval with the duration of the disease. There is one feature of continued fever, to which, heretofore, we have seen no satisfactory explanation that we think can be accounted for rationally according to the pathology here suggested; we refer to the paroxysms and excerbations which frequently complicate the course of continued fever. We would attribute these paroxysms to the extension of the irritation from the ganglionic to the cerebro-spinal centres, and we conceive that it is only under such circumstances that we find these intercurrent paroxysms masking the course of the typhoid affection. By this means there is effected a true *blending of types* from a blending of proximate causes, and the two sets of phenomena exist in combination; a continued fever characterized by paroxysms of exacerbation. In the same manner, on the other hand, can we conceive of paroxysmal fever becoming continued under favourable circumstances, by the transmission of irritation from the cerebro-spinal to the ganglionic system.

As the abnormal innervation in the sympathetic system can produce a continued accelerated action in the heart, in typhus and typhoid fever, so, likewise, can the diarrhœa of the typhoid type be shown to be a result probably of a similar condition. The normal action of the ganglionic system endows the intestinal canal and other viscera with the function of healthy secretion; but during the existence of the typhoid state this proper action is destroyed; in place of the organs being the seat of a normal and proper circulation, which is necessary for the due exercise of their function—secretion, the vessels become the seat of obstructions and congestions, the secretions become more abundant, but abnormal and vitiated; we have then *diarrhœa.* As these congestions become more marked, we find the paralyzed and over-distended vessels giving way, allowing submembranous effusions of blood, and occasionally considerable hemorrhages—all being the result of the altered condition of the innervation of these organs. Thus, what in its beginning was a purely dynamical affection, soon becomes organic; for without the proper supply of ganglionic nervous influence, we have seen, from the above-mentioned experiments, that the circulation ceases, the capillaries become turgescent, especially in highly vascular secretory organs (as the mucous surfaces, or the glandular plates of Peyer, for instance), effusion of lymph takes place, and, as above stated, finally, the capillaries are ruptured, and the tissues in certain places rapidly disintegrate by the process of ulceration—which is the actual condition of things in the intestinal disease of typhoid fever.

From what has already been said in relation to the distinctive features of the two types of continued fever—typhoid and typhus, their interpretation, according to the pathology herein argued, will have been, doubtless ere this, naturally suggested. We have seen that *typhoid* fever is marked by an accelerated pulse, more or less nervous derangement, an altered condition of the blood, frequently a *mild* cutaneous eruption, diarrhœa, and meteorism. On *post-mortem* examination, we find lesions; viz. congestions and ulcerations of a peculiar character, that is, simulating those produced by experimental sections of the nerves in all those parts supplied by the *visceral* portions of the ganglionic system of nerves. On the other hand, we have seen that *typhus* fever is characterized by a somewhat more accelerated pulse, much more marked nervous derangement, the same altered condition of the blood, well-marked and *always serious* alterations in the capillary circulation of the *skin*, amounting often to actual ecchymosis, while the *post-mortem* examination shows almost entire *exemption* from lesion in the abdominal viscera. Thus, we find that while both diseases have all their general symptoms so exactly similar that we are forced to acknowledge their identity, and see in them what is essentially but one disease, yet typhoid fever has its principal and most prominent manifestations in the abdominal viscera —internally; and typhus fever manifests itself in aberrations of the circulation, very analogous to those of typhoid, but occurring in the capillaries of the *cutaneous* surface.

Now the ganglionic pathology is the only theory by which such marked incongruities in the two forms of what, to the observation and scrutiny of every one, must ever appear as one disease, can be perfectly and satisfactorily reconciled. We cannot deny that the two are but types of the same disease; yet how incongruous and strange it is that, in certain cases (*typhoid*), diarrhœa and intestinal lesion should appear the main—the most important features; while in the other cases (*typhus*), undeniably of the *same disease*, even more grave and threatening, there should be not a trace of diarrhœa, and on *post-mortem* examination no intestinal lesion whatever, but, instead, serious disease and congestion of the *skin*, with subcutaneous sanguineous effusions, similar to the submembranous sanguineous effusions of the typhoid type. Indeed, from the very smallest degree of attention must result the conclusion that, in the two cases, *the disease is one and the same*, but seated in different portions of the organism; and this conclusion will accord exactly with what we have considered the distinctive pathology of the two forms, viz.

that in each type the disease is located in a different portion of the ganglionic system. There are certain parts of the system which are affected in both forms of the disease—as the ganglia supplying the heart; but after this, the two types have entirely distinct and separate sets of ganglia, the morbid action in which gives rise to their respective manifestations. In *typhoid fever*, the *internal* or *visceral* isolated ganglia, such as the semilunar, &c., are the seat of the morbid action; and these supplying mainly, we may say entirely, the abdominal viscera, and having but little connection with the other or external portions of the organism, these viscera become the seat of nearly all the morbid phenomena; while that little implication of the cutaneous surface and general nervous system, which we often observe, is entirely due to the remote and very obscure connection which their isolated ganglia may have with the nerves supplying these parts.

Now, in the *typhus* type, the same disease, or morbific agent (its exact nature we do not pretend to define), affects an entirely different set of nervous centres—a set of ganglia which, by their anatomical position, their internal and universal relations with the anterior and posterior roots of the spinal nerves, are plainly destined to preside over the capillary circulation of parts more superficial—the cutaneous surface. We have reference to the *vertebral* sympathetic ganglia; and, in attributing the location of *typhus* fever to these ganglia, we have a ready and satisfactory interpretation of all its distinctive characteristics. The skin becomes congested and ecchymosed (petechial), because its circulation is dependent upon and controlled by innervation derived from these vertebral ganglia; which ganglia being the seat of abnormal action (perhaps paralysis), innervation is deficient, the cutaneous circulation is retarded; in certain places there is obstruction, with actual rupture and effusion, giving rise to petechiæ. The general (cerebro-spinal) system is more seriously involved in typhus than in typhoid fever, because the connection is more direct between the vertebral ganglia—which are the seat of typhus—and the cerebro-spinal system. In a word, then, we would locate *typhoid fever* in the *visceral* portion of the ganglionic system, and *typhus* in the *vertebral* portion.

We are fully aware that our views of the pathology of typhoidal fevers would be greatly corroborated, could there be discovered any appreciable *lesion* in the ganglionic nervous centres, in subjects who have died during their progress; but, like the pathological anatomy of all the nervous system, this would be an investigation attended with

many difficulties; for histological changes in the nervous centres are of such a character that though they may be competent to subvert the intellect, entirely paralyze or destroy the functions of a large portion of the organism, and ultimately, upon the most positive rational evidence, *seem* to be the cause of death, yet on examination the alterations observable in those centres are of the most insignificant and irrelevant character, pertaining only to the involucre, while the centres themselves, which, from the previous symptoms, had been plainly the true seat of the disease, have been found apparently normal and intact. These changes, then, are probably molecular and inappreciable with our present means of investigation, and will require years, and far more perfect appliances, to incorporate them among the positive and demonstrable things of our science. Still, there are occasionally isolated facts, even in the *pathology* of the ganglionic nervous centres, which we may refer to in corroboration of our opinion that these centres are affected in typhoidal fevers, and that such affection gives rise to its characteristic symptoms, or to phenomena quite analogous in their nature. The case reported by Professor Lobstein is of this nature. It was that of a young girl who had suffered from paralysis of the lower extremities for some time, but for three months previous to her death laboured under the most incurable *diarrhœa* with tormina, &c. On making a *post-mortem* examination, there was found a large abscess on the left side, extending from the sixth to the tenth dorsal vertebra. On opening this abscess, it was found that the *trunk* of the left *sympathetic nerve* was entirely *destroyed* from the sixth to the twelfth vertebra, *and in the lumbar* portion the *same nerve was in a state of inflammation.**

There are also two cases reported as occurring in the practice of Dr. Aronsshon, of the Strasburg Hospital: The first, that of a man forty-seven years old, affected with *diarrhœa.* He died of a tumour in the abdomen, and it was found that "the *semilunar ganglia* were affected with *distinct inflammation.*" The second case was a woman aged about thirty years, who, in her second pregnancy, was subjected to vomiting throughout the whole of her gestation. She was also affected with a *furfuraceous eruption* upon the breast and arms, with *swelling* of the *limbs*, and with *diarrhœa.* On a *post-mortem* examination, the villous coat of the stomach was found inflamed and thicker than usual, especially towards the pylorus, "and the semilunar ganglia were found in a *state of genuine inflammation.*"

* Structure, Functions, and Diseases of the Sympathetic Nerve, p. 147.

"In the body of a boy ten years of age," says Lobstein, "who had died from the retrocession of a *miliary eruption*, attended with symptoms of great anxiety, oppression of the chest, and distension of the epigastrium, I found a place in the left trunk of the *intercostal* (which is the old name for the sympathetic) *nerve, highly inflamed* between the eighth and tenth ribs, *with a phlogosis of the ninth and tenth thoracic ganglia*, and their two anastomotic branches with the costal nerves."

The following observations are quite pertinent to the state of congestion in which the lungs are almost invariably found, to a more or less degree, in typhoid and typhus fever. "On examining into the condition of the nerves in diseases of the lungs, I discovered another alteration which is peculiar to these organs; to wit, in that species of *peripneumony*, in which the lungs became red and *slightly indurated*,* and which, I think, should be called spleenification; the *nervous filaments* attending the ramifications of the bronchia *were* found equally *red*, a little more tumid, but much more tender than usual; so as to be *broken by the slightest degree of force*."† And, lastly, the same author‡ quotes a case still more in point, from the writings of Professor Autenrieth, of Tubingen, wherein it is asserted, though he does not appear to connect the circumstance with the pathology of the disease at all, that he has *seen* the *abdominal nerves of the ganglionic system somewhat changed in subjects who have died of typhoid fever.*

The above cases, though not conclusive, are at least strongly corroborative of our view of the pathology of typhoid fever; for while we must admit that the diarrhœa, the eruption, the pulmonary congestion, œdema, &c., might have been produced by other causes than disease of the ganglia found inflamed or divided, still, when these coincidental circumstances are viewed in connection with the known result of artificial section of accessible portions of the sympathetic nerve, as those about the neck and eye,§ and also in view of the entire dearth of experiments and facts bearing upon this portion of the ganglionic system, we must regard them as significant and valuable, even though they afford what we may term only a legitimate suspicion of the correctness of our pathological views.

* Exactly what is described by Dr. Flint as the pseudo-pneumotis of continued fever.

† Lobstein, p. 139. ‡ *Op. cit.* p. 137.

§ See experiments of Panfour du Petit, Dupuy, John Reid, and others, already referred to.

We have now completed our investigations in relation to this intricate, but, at the same time, most interesting topic of pathological inquiry; we have reviewed its history, and collected from every source within our reach as complete a delineation of its prominent and characteristic phenomena as has been necessary for their full development. In so doing, we have been struck with the vast number of reliable and significant facts our science is in possession of, in regard to this disease. No disease in the catalogue is more invariable in its characteristic manifestations; no disease has been more diligently studied, or has enlisted in its investigation such faithful observers. Our knowledge in regard to its observed *phenomena* and *facts* is clear, well defined, almost certain; to complete the science in regard to it, it has but remained that these cognate, well-ascertained facts and phenomena be rationally and correctly *interpreted*, that its true pathology might be *deduced*. To this arduous, though not unpleasing task, not without many misgivings, we have earnestly and diligently devoted ourselves, more with the hope that our labours would prove suggestive to others of the true mode of arriving at the real pathology, than that we should be able to supply the want or remedy the deficiency.

Starting with what we considered the rational assumption that the pathology of typhoidal fevers is in the ganglionic system of nerves, we have compared their characteristic traits and phenomena with, first, the *normal* action of this portion of the nervous system, then with the known and well-established results of *experimental irritation and action* of various portions of these nerves, and we have found that the analogy is sufficiently close to admit the legitimate inference that the symptoms and pathological lesions of typhoid and typhus fever are produced by a normal action in certain portions of this system of nerves. First, because no typhoid or typhus phenomenon ever occurs, except in regions supplied by this system; secondly, because the peculiar phenomena of these diseases occur in a more marked degree, in those parts most abundantly supplied from this source; and thirdly, because the nature of these symptoms are always found more purely and characteristically typhoid in those portions of the organism supplied exclusively by this kind of innervation. And farther, on the other hand, we are forced to admit the truth of these impressions, because we have hitherto had no theory or legitimate and consonant combination of theories, to our own mind, as competent to the full and rational explanation of *all* the phenomena of the disease as the one now offered.

Practical Deductions.—Pathology is only valuable when it has a tendency to the prevention, amelioration, or cure of disease, and the results of our most successful labours in this department are but nugatory unless in them can be found a clue to a more rational and perfect management of the affections to which they refer.

If the views embodied in the foregoing treatise are correct, the following practical inferences must present themselves as legitimate, if not inevitable: First, that in the management of this class of fevers the strictest attention should be paid to the improvement of the tone of the nervous system; all depressing measures, or such as are calculated to exhaust the nervous energies, as depletion by purgation or otherwise, should be scrupulously avoided; and secondly, that in their place means of an opposite character should be invoked. Indeed, that treatment now most in favour, though but empirically* applied, will be found on the admission of the above pathology the most rational, and to offer the best hope of success. We have reference to that treatment which is addressed almost exclusively to the nervous system, and has for its object the sustentation and elevation of its energies. Some of the means employed have been attended in their application with the most marked beneficial results. Among these, we would mention the plan of Dr. Percival, wherein the disease was treated by frequent profuse cold affusions, especially in the case of children; which treatment we should rationally expect, from the known effect of cold water thus applied, to improve the condition of the depressed nervous centres. The administration of stimulants, as camphor, quinia, brandy, opium, turpentine, and the ethers, have all been favourably known to the profession as remarkably efficient in these fevers.

In relation to the beneficial results recently obtained from large doses of quinia, by Dr. Dundas and others, we can readily appreciate what vast benefit may accrue from them, especially in cases where the cerebro-spinal system of nerves are extensively implicated, and where the disease is marked by regular obstinate paroxysms, for quinia, though it possesses, in our opinion, but little influence over the ganglionic system itself, still, would relieve these periodic exacerbations by its effects upon this system, through the cerebro-spinal nerves (which in these cases we regard as the instigator of the paroxysm), upon which most of its power is expended. That the doses required should be large, we can easily understand, as any

* Of course, this term is not applied in its offensive sense.

effect produced upon the ganglionic system through the cerebro-spinal is only accomplished by powerful and long-continued impressions, on account of the comparative isolation of the two systems from each other.

To those who are in the proper field for such experiments, and possessed of the proper facilities, we would recommend the trial, in typhoid and typhus fevers, of such agents as are known to possess a direct power to stimulate the nervous system, even when in a state of partial paralysis—such an agent is *strychnia*. This we would suggest as applicable in minute but efficient doses, with the view of waking up and restoring the diminished energy of innervation, upon which the impaired function depends, in the same manner that we would advise it in other similar cases where the cerebro-spinal system was implicated.

The above is all we offer in regard to treatment; there are many measures of a like nature, which, were we writing a complete treatise on the *management* of these diseases, would require a full and extended consideration, as also the measures and applications which the emergency of each case will naturally suggest and demand.

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III.

PRIZE ESSAY.

THE

EXCITO-SECRETORY SYSTEM OF NERVES.

ITS RELATIONS TO

PHYSIOLOGY AND PATHOLOGY.

Observation becomes experiment when used in severe processes of induction.—Victor Cousin.

To this Essay the prize of one hundred dollars was awarded at the tenth annual meeting of the American Medical Association.

MAY, 1857.

PRIZE ESSAY.

THE EXCITO-SECRETORY SYSTEM OF NERVES.

THE object of the present essay, is to develop more fully a function of the nervous system, which, though enunciated and described nearly seven years ago in this country,[1] is only now beginning to be fully recognized by the profession in Europe.[2] We refer to that function which has been termed the *Excito-secretory*,[3] and which results from the relation subsisting between the excitor or sensitive nerves of the cerebro-spinal and the secretory branches of the ganglionic system. It is by virtue of the particular system of nerves thus resulting, as we hope to demonstrate in the present paper, that a great many of the important acts of nutrition and secretion are modified in circumstances both of health and disease, and further, that it is to aberrations in this particular function that many of the heretofore, mysterious phenomena of diseased action are mainly attributable.

The prosecution of this very interesting inquiry is necessarily embarrassed by many difficulties. The generalization of kindred facts, long established in other relations, and made the basis of induction in those relations, when they are now transferred to an

[1] The Influence of Dentition in producing Disease. By Henry F. Campbell, M.D., Demonstrator of Anatomy in the Medical College of Georgia. Medical and Surgical Journal, vol. vi. p. 321. June, 1850.

[2] London Lancet, American edition. March, 1857. Excito-Secretory System of Nerves. By Marshall Hall, M. D., F.R.S., &c.

[3] Vide Transactions of the American Medical Association, vol. vi., art. Sympathetic Nerve in Reflex Phenomena. By Henry F. Campbell, of Georgia. May 3d, 1853.

entirely new position, and made to serve as data for evolving a new result, in many instances opposed to those of their former interpreters, will give to our reasoning a character of novelty, which we fear may be stigmatized as *innovation* by those holding adverse opinions to our own. Then, again, the data for our deductions being scattered throughout the vast domain of medicine, and oftentimes associated with other facts which are entirely irrelevant, it is a matter of no small labor to dissolve these associations, and to place them in their proper and pertinent relations for the deduction we wish here to accomplish. We will, notwithstanding, give ourselves to the uninviting task, even with these forbidding aspects of it frowning upon us, for we are impelled to it by the reflection, that the field is a rich one, that the fruit is ripe and ready for harvest, that the data accumulating for years need only a proper interpretation to make them yield the very results we hope to draw from them, and further, that did *we* not perform the present duty, many years cannot elapse before some other will give himself successfully to the same important work.

THE NERVOUS SYSTEM.

The Nervous System, as has been long admitted, is divisible into two grand portions, the Cerebro-spinal and Ganglionic, or to speak physiologically, the nerves of animal life, and the nerves of organic life. In the perfect being, endowed with these two systems of nerves, a multitude of facts, the result both of observation and experiment, go far to establish the belief, that though evidently performing functions in the animal economy of very diverse characters, these two portions are yet intimately connected with each other, and further, that such connection in function, as well as in physical relation, is indispensable to animal unity in those beings who possess both these departments of the nervous system.

As in the following essay we shall be required constantly to refer to the actions of these two systems of nerves, it will not be improper, in the beginning, to recall briefly a sufficient number of the admitted facts in relation to their functions, to establish a clear view of their respective parts in the animal economy. Firstly, then, it is to the cerebro-spinal system, with its varied endowments of sensation, motion, special sensation, and perhaps, even intellec-

tion,[1] that the being owes his adaptedness for a relation with the objects of the external world. Between the various portions of this great system, while there exist separations and distinctions of the most obvious character, there are also relations mutual and intimate, which are of the first importance to the individual. The senses, endowing him with the æsthetic faculty, enable him to spread before him on the field of consciousness, all which is passing in the world without, while the internal, or intuitive phenomena, complete the contents of this same field.[2] Thus, the sensible world without, and the world of intellect within, according to some,[3] are pictured upon a canvas or blank sheet, and presented to the reason and the judgment, as data by which the being may direct and shape his conduct under the influence of a supreme principle of our organization, the Will. These constitute the voluntary acts of animal life. Then, on the other hand, there are certain muscular acts, equally amenable to the dictates of the will, which are performed independently of the cerebral organs apparently, and without putting in requisition either reason, judgment, or the will, under the influence of the, so to speak, vicarious power of reflex action. This last set of phenomena constitute a body of facts, classed under the general term of excito-motory action, and for the full development of which, science is indebted to the genius and labors of Doctor Marshall Hall.[4]

The other portion of the nervous system, termed the Ganglionic, Sympathetic, or Organic Nervous System, was, for a long time, a mystery to physiologists, and therefore became the subject of much observation and experiment. The views of Willis,[5] Vieussens,[6] Lancisius,[7] Winslow, Meckel,[8] Zinn,[9] and Scarpa,[10] having finally given place to the more rational suggestions of Bichat[11] and

[1] Herbert Mayo, on the Nervous System. "Mind and Matter," Sir Benjamin Brodie.

[2] Consciousness is the accompaniment of all our faculties, and, so to speak, their echo. . . . . Consciousness is nothing else than the rebound of the action of all our faculties.—Victor Cousin, *History of Modern Philosophy*, vol. i. p. 322.

[3] Locke.

[4] Lectures on the Nervous System and its Diseases. London, 1836.

[5] Nervorum Descriptio et usus. Geneva, 1695.

[6] Neurograph Univers, lib. 3 de Nervis, cap. v.

[7] De Ganglia Nervorum.

[8] Mémoires de Berlin, 1749.

[9] Ibid., 1753.

[10] Annal. Anatom. de Gangliis.

[11] Anatomie générale.

Riel,[1] this system of nerves has, since their day, become to be studied more in reference to the acts of nutrition and secretion, than in any other relation. Bichat named it the nerve of organic life, and Riel, having imbibed the idea from him, attributed to it the same function.

Upon this view, gradually advancing, observation after observation has been made, and experiment upon experiment performed, until Bichat's and Reil's theories, in regard to its use, have been in most part verified, and, at the present day, there is scarcely any portion of the organism about whose function opinion is better established, than that the formerly called sympathetic nerve, or ganglionic system, is the system presiding over nutrition. Inasmuch as it is by *secretion*, or some act analogous to it, that all the processes of nutrition are accomplished, it has gradually gained the appropriate name of the *Secretory System* of nerves. It is of this secretory system of nerves, and more particularly in its connection with the nerves of Relation—the cerebro-spinal—that we have to treat in the present discussion.

In the investigation of this very important subject, we shall, to a certain extent, present an analysis of those observations and experiments, accumulated from an early period to the present time, which appear to us to have a particular bearing upon our subject, in order that we may deduce from this analysis, if possible, a fuller development than has been heretofore done, of the excito-secretory system of nerves.

Experiment, without correct analysis, is ever inadequate and unproductive. Adopting for our motto the significant sentiment of M. Victor Cousin, that "observation becomes experiment when used in severe processes of induction," we claim for our generalization of heretofore unapplied results, an importance equal to that of actual experiment itself. We would not, however, appear to depreciate the value of experimental research; so far from this, we congratulate ourself upon the valuable body of facts, developed by this means during the last and the present century, and which now are accessible to every one who will enter the laborious field of inductive reasoning. In our humble opinion, the facts already accumulated are abundant, link after link has been fashioned, and nothing remains for the physiologist but to weld them together,

[1] Archiv. fur die Physiologie.

and to construct them into a chain of evidence by pertinent and impartial generalization.

As will be readily observed, by a reference to all late works on the subject, these two systems of nerves, viz., the cerebro-spinal and the secretory, are ever found in the most intimate relation with each other. While we do not conceive that it is here necessary to enter minutely into the anatomy of the two systems, we deem it advisable to refer briefly to some of the more important connections subsisting between them, in order to illustrate our doctrine of the excito-secretory function, resulting directly from a consideration of these connections.

SECRETORY SYSTEM OF NERVES.

The sympathetic, or secretory system of nerves, consisting of a chain of ganglia, extended, it is thought by some,[1] from the anterior communicating artery of the brain to the ganglion impar, at the lower portion of the spinal column, is found everywhere in intimate relation with the vascular system, and particularly with the arteries. It is evidently the nerve of the bloodvessels, and the branches follow and ramify upon their coats, clinging to and encircling them "as the ivy entwines itself around the oak." Wherever there is a secretory surface, or a gland, which is only a complex secretory surface,[2] wherever the metamorphosis of blood is going on, or the elimination of a secretion is being performed, there we find distributed, in greater or less profusion, the *branches* of the ganglionic system; while in convenient collocation to every secretory apparatus, we find also one or more of the ganglionic centres of this system, apparently designed to superintend and direct, and to supply nervous force for the mysterious operation. In direct proportion, too, to the activity of the nutrient or secretory process, do we find these centres of peculiar energy, allotted to any particular portion of the organism, and, wonderful to consider, even do the temporary and arbitrary circumstances of an organ seem to control and measure the amount of actual nerve-substance which that organ, or system of organs, shall, for the time being, have to direct and superintend its nutrition. The well established and generally admitted

[1] Ribes.

[2] Vide Carpenter's Physiology. Owen's Lects. Compar. Anat., and Grant's Outlines Comp. Anat.

researches of Dr. Robert Lee, together with the pertinent analogies found in the other tissues of the uterine system, as the rapid increase in all the tissues of the uterus, have placed this last fact beyond all reasonable doubt. Indeed, if we admit that the ganglionic system is the vis incita to nutrition, and this we must admit; if we recognize any relation between the amount of nerve-substance devoted to any part, and the energy of nervous action in that part, and this we must recognize, there can be no escape from the induction that the ganglia discovered by Dr. Lee are *necessary* to the increased action going on in the organs of generation during the period of gestation, even though they had *never* been discovered. Dr. Lee is but the pioneer probably in this field of research, and we would here almost venture the opinion, that time must develop similar growths in the ganglia lying adjacent to *morbid* epigenetic tissues in *every* part of the organism.

It would be an improving and not unpleasing exercise to enter into an extended review of the history of the various experiments by which the fact has been demonstrated, that the ganglionic system is truly the secretory system of nerves, but time and the special object of this essay will not admit of such discursive views; we wish to evolve, as briefly as possible, the excito-secretory system, and will, therefore, consider only those points in its history which are available for that special purpose. As early as the year 1732, Pourfour du Petit found that the division of the trunk of the sympathetic nerve, opposite the fourth or fifth cervical vertebra in dogs, was very rapidly followed by great disturbance in the circulation of the eyeball, producing inflammation, flattening of the cornea, retraction of the eyeball, with protrusion of a fold of the conjunctiva, *and a flow of tears*, and ultimately ulceration and destruction of the entire organ.

The experiments of Dupuy[1] upon horses, wherein he extirpated the superior cervical ganglion, were followed by the same *local* results, with regard to the eye, and also by the singular, *general* effect of producing an *eruption over the whole cutaneous surface*, which was succeeded by general emaciation and an *œdematous state of the limbs*. Some of Arneman's experiments on the nerves,[2] confirm the above results, for in them, as reported, we find that the effect upon the eye *was to produce an ecchymosed and bloodshotten*

[1] Journal de Médecine Chirurgie, &c., Decembre, 1816, tome xxxii. p. 340.

[2] Gottingen, 1787.

appearance. Dr. John Reid,[1] who also experimented in this field, cutting and irritating the sympathetic nerve in the neck, leaves a similar record, viz: that the conjunctiva became *red and congested* in a *few minutes* after the operation. In the experiments reported by Molinelli,[2] Cruickshank,[3] Mayer, of Bonn,[4] and Brachet,[5] the unvarying effect of ligation or section of the sympathetic in the neck, has been to affect, or in some manner modify the circulation of the blood in the vessels of the conjunctiva and other parts of the eye, while on the other hand, those experiments reported by Flourens[6] and others, wherein the *cerebro-spinal* nerves and centres have been destroyed, go far to show that the circulation is independent to a great degree of this latter system.

All of the above relate to experimental physiology, and such facts have been accumulating for more than a hundred years; but there is another department which should be ever considered of equal value, if not more important, in which facts accumulate and are occasionally recorded, which possess the most significant and pertinent bearing upon the physiology of the nervous system. It is scarcely necessary to say, that we refer to the observation and record of *pathological* phenomena. It has ever appeared to us, that one great cause of the slow and uncertain progress of physiological science, has rested in the fact, that physiologists have not been generally, either bedside or autopsic observers, but mainly experimenters—thus being cut off from the observation and discussion of some of the most significant phenomena of the nervous system. With diligent and intelligent observation, proper generalization and impartial induction, the clinical and autopsical facts would be found, often, to supersede the most troublesome and unreliable experiments, and, in the end, could be made to yield a far richer and more abundant treasure of results. Unfortunately, from the causes mentioned above, viz: that practitioners of medicine are not often critical physiological observers, we find but few of these valuable facts on record, from which to evolve results in our present investigation. There are, however, a few, and among this few, some are

[1] Edinburgh Medical and Surgical Journal, August, 1839.

[2] Comment Banoniensi, tom. iii. 1755.

[3] Medical Facts and Observations, Philosoph. Transactions, 1795.

[4] Journal der Chirurgie, 1827.

[5] Recherches Expérimentales sur les Fonctions du Système Nerveux Ganglionaire.

[6] Système Nerveux, 1849, p. 214.

of the most significant character. It will be observed, that in most of the experiments performed on the ganglionic system, the ganglia in the cervical region have been selected, and this is generally stated to be on account of their greater accessibility; the abdominal ganglia have been only in a few instances[1] experimented on, and these experiments, on account of the important and sensitive parts cut through to reach the nervous centre operated on, were followed by the most unsatisfactory and unreliable results.

In the experimental investigation of physiological problems, the mode of procedure is first to make the experiment; for instance, uncover a nervous centre, apply an irritant, or make a section of it or of its afferent or efferent nerves, and note the effect produced upon the parts of their distribution; in the investigation of these problems, by pathological observation, the course is reversed; a certain set of inexplicable phenomena arrest the attention—the *effect*, so to speak, is first noted, and afterwards, the cause is investigated, and the connection between cause and observed effect thus traced, and the physiological principle satisfactorily evolved. Which, we would ask, in these two processes, is better entitled to be called the experiment? It is our humble opinion that neither has the advantage, but that the "*observation*," under these circumstances, "becomes experiment," and is fully as useful in the induction as any artificial experiment could possibly be, and that it will *yield* as much.

Of the above class, will be found the following pertinent facts recorded by various authors, but never dwelt upon and allowed that amount of significance in a pathologico-physiological point of view which we think they deserve.

"In a case of *diabetes*, in which the urinary bladder was very much dilated," says Lobstein,[2] "Dr. A. Duncan[3] observed, that the sympathetic nerve was three or four times larger than usual, from its ingress into the abdomen to its termination in the pelvis." Here seems to be a relation between the excessive secretion of the kidney and the increased size of the secretory nerve, which strongly corroborates the attributed function of that nerve.

Lobstein detected an *enlargement of the nerves of the right semilunar ganglion* in an unmarried woman, 25 years of age; she had been affected with a *chronic miliary eruption* previous to her death.

[1] Flourens, op. cit., p. 232. Semilunar ganglion.

[2] Structure and Functions of Sympathetic Nerve.

[3] Reports of the Practice of the Clinical Wards of the Royal Infirmary of Edinburgh, 1807 to 1818.

"It has been proved," says Lobstein, "by observations undertaken for that purpose, that the nerves may not only be increased in thickness, but in number likewise." 1. "I dissected," he continues, "a case of hydro-sarcocele in the spermatic cord, in which I detected many nervous filaments, though evidently belonging to the sanguineous vessels, of which one extended to the vas deferens. I convinced myself in each case, with the microscope, that I had not mistaken the lymphatic vessels for nervous filaments. In a thyroid gland of remarkable size, weighing four pounds, which had been converted into innumerable cysts, abounding with limpid gelatinous humor, I discovered a *great many nerves.* Three nervous trunks, which proceeded from the laryngeal nerve and upper cervical ganglion, entered the gland on each side in company with the superior thyroid arteries. Each arterial branch had an attendant nervous filament, not connected immediately with the tunics of the vessels, but adhering to them by the aid of cellular membrane. But all these nervous branches which were linked together by anastomotic filaments, formed a beautiful plexus; they were united with the nerves of the opposite side, and thus formed a kind of crown around the superior part of the gland. From this crown branchlets descended upon the external face of the gland, one of which was joined by anastomosis with an ascending filament from the recurrent branch of the par vagum. Nevertheless, all these thyroideal nerves, which formed a network about the arteries at the upper margin of the gland, that excited my admiration, presented nothing unusual in their structure or appearance."

We would here ask, if anything could be more corroborative than this pathological observation of Dr. Robert Lee's dissections and observations of the nerves of the gravid uterus, and also of our own remark, made a few pages back, that the time will probably arrive when for every morbid growth *there will be discovered an increase in the actual nerve-substance* in the adjacent parts of the *secretory system connected with such growth.*

"But," continues Lobstein, "the *contrary* of this phenomenon is observed in other instances; to wit, where the number of nerves is greatly diminished. I found a kidney entirely destroyed by suppuration, with the exception of a coriaceo-lardaceous capsule, which still existed and was full of pus. The pelvis was distended with matter as well as the ureter, the parietes of which were very thick and hard. There were also observed some indurated and apparently scirrhous adeps upon the surface of the same kidney, which

is frequently found in other organic diseases, and especially in those produced by chronic inflammation. The *renal plexus* was composed of *only five branches*, which were very little connected together, but exhibited a ganglion half a line broad. When the kidney with its nerves was dried, an oily fluid was exuded from the nervous branches; but the nerves of the other kidney, which was healthy when dried in a similar way, did not exhibit this phenomenon."

A girl of ten years of age suffered from paralysis of the lower extremities for some time, but for three months previous to her death, she labored under the most incurable diarrhœa with tormina. On making a post-mortem examination, there was found a large abscess on the left side, extending from the sixth to the tenth dorsal vertebra. On opening this abscess, the trunk of the left sympathetic nerve was found *destroyed entirely* from the sixth to the twelfth vertebra, and the lumbar portion of the same nerve was in a state of inflammation.[1] Dr. Aronsshon, of the Strasburg Hospital, reports two cases; the first, that of a man, forty-seven years old, affected with diarrhœa. He died with a tumor in the abdomen, for which he was examined, and it was found that the *semilunar ganglia* were *affected with distinct inflammation.* The other case was that of a woman, aged about thirty years, who in her second pregnancy was subjected to vomiting throughout the whole gestation. She was also affected with a *furfuraceous eruption upon the breast and arms*, with *swelling of the limbs* and with *diarrhœa.* On post-mortem examination, the semilunar ganglia were found in a state of genuine inflammation.

We have quoted the above records with the view of illustrating the varied effects resulting from injury to the ganglionic system and its branches. In them we have seen that such injury, either produced in experiment or in the progress of diseased action, has been invariably to modify the circulation and the secretion of the parts to which its branches were distributed; thus, firstly, in the various experimental sections by Arneman, Pourfour du Petit, Dupuy, and Reid, the eye, and the various appendages upon which the branches were distributed, became *ecchymosed* and *bloodshotten*, and the secretion modified, while, in most instances, the organ was finally entirely destroyed. Secondly, in the cases reported by Lobstein, we find that a case of *diabetes* was accompanied with an extraordinary development (four times their usual size) of the secre-

[1] Op. citat., p. 147.

tory nerves supplying the kidney; that, in another case, injury to branches of this system was found to be accompanied with diarrhœa, while, in several, cutaneous eruptions and œdematous states of the body were also concomitants of such injuries; whether experimentally produced, or from disease in the centres themselves.

The above facts, together with many others recorded since, and which are every day being brought to light by the indefatigable labors of experimental physiologists, we think place the function of the ganglionic system beyond all doubt; but there is one other series of experiments to which we desire to refer before entering into the discussion of the excito-secretory system, because in them, although they were not made for this purpose, we think we find even a better illustration of the secretory function of the ganglionic system than in any of those heretofore adduced. We refer to the experiments of M. Magendie to develop the function of the *fifth pair* of nerves. We find these experiments quoted by Dr. Alcock in the *Cyclopædia of Anatomy and Physiology*,[1] and as there reported and commented upon by Dr. Alcock, we find in them a demonstration of the fact, that an author's results and his records are sometimes less useful to himself in arriving at the truth than when made subservient to that end, in the deductions of another, who may approach them without having been committed to any foregone conclusion.

The present treatise by Dr. Alcock on the anatomy and functions of the fifth pair of nerves, we regard as the best and most reliable embodiment of the science upon the subject, and while we have reason to dissent from some of the author's views in his strictures upon M. Magendie's conclusions upon the significance of his experiments, we cannot commend the paper too highly for the clear and accurate views put forth by him, both in regard to the anatomy and the physiology of this important part of the nervous system.

The discussion of the vital properties of the fifth pair of nerves, this writer arranges under the four following heads: "1. Its sensibility. 2. Its influence upon the faculties of sensation and volition, as also upon the ordinary sensibility of the parts to which it is distributed; and 3. Its relation to the special senses, and *its connection with the function of nutrition.*"

With the two first divisions of the subject we at present have but little to do. It appears that the sensibility of the fifth pair was first

[1] Dr. Robert Bentley Todd. London.

experimentally and definitely demonstrated by Sir Charles Bell, and that he directed attention to this point, first, in a paper published in the *Philosophical Transactions* for the year 1821. This nerve, when exposed in an ass, "gave acute pain."[1] His observations were soon succeeded by those of Herbert Mayo,[2] who also experimented upon the ass, pinching the cerebral extremity of the trunk of the nerve, and producing the same result as in Bell's experiment. Magendie repeated these experiments, and by his and a multitude of similar experiments and observations from that time to the present, the physiology of the nerve in its relation to sensibility, has been fully established.

In relation to the second head, it is only necessary to note, that the restriction of the voluntary motor influence to the non-ganglionic portion of the fifth pair, was first announced by Herbert Mayo, and since then the question has been considered as entirely settled by most physiologists.

But it is more particularly in the relation of the fifth nerve to the processes of nutrition, that we are at present interested; and it is to this portion of Dr. Alcock's last division of the subject that we wish now to refer.

"The last question proposed to be considered with reference to the functions of the fifth nerve is in connection with *nutrition.*

"The opinion that this nerve controls the nutrition of the parts which it supplies, has been advocated by Magendie more particularly with regard to the eye. It has been already stated that we are indebted to this writer for information in regard to results of the division of the entire trunk of the nerve, within the cranium. Of these, the most prominent is the entire loss of sensibility on the same side of the face, and in regard to the eye especially, loss of sensibility in the conjunctiva, upon which the most irritating chemical agents, then, produce no impression. These immediate effects of the section were followed by others not less remarkable; on the next day, the sound eye was found inflamed by the ammonia which had been applied to it, while the other presented no trace of inflammation. *Other changes, however, supervene.* The cornea of the eye of the side on which the section is made, twenty-four hours afterwards begins to *become opaque;* after seventy-two hours, it is much more so, and five or six days after, it is as white as alabaster. On

[1] Cyclopedia of Anatomy and Physiology.

[2] Physiological Commentaries, No. 1, p. 110. 1822.

the second day, the conjunctiva becomes red, inflames, and secretes a puriform matter. About the second day, the iris also becomes red and inflames, and false membranes are formed upon its surface. *Finally, the cornea ulcerates, the humors of the eye escape, and the globe contracts into a small tubercle.* In endeavoring to ascertain the cause of these changes," continues Dr. Alcock, "Magendie, on the supposition that they might be owing either to the continued exposure of the eye to the air, or to the want of the lachrymal secretion, divided the portio dura in one rabbit, the effect of which is to destroy the power of closing the eyelids; and from others he cut out the lachrymal gland; but in neither case did opacity of the cornea succeed. The sequence of the effects mentioned after the section of the nerve, might naturally lead us to infer that the loss of nervous influence gives rise to them. But such is not the inference drawn by Magendie, *nor indeed can it be admitted!* Absence or subtraction of an influence cannot be directly the cause of an alteration in the condition of an object otherwise than by allowing it to come or return to a state from which it is preserved by the presence of the influence, and there is no good reason, either theoretical or experimental, for believing that the state induced in the case under consideration is one in which the eye would necessarily be—which, in fact, would be natural to the organ but for the restraining influence exerted through the fifth nerve." And a little further on Dr. Alcock remarks: "But indeed there does not appear any reason for admitting that the alterations which took place in the condition of the eye were produced directly by the loss of nervous influence. Having, as he conceived, disproved, by the experiments related, the idea that the alterations were owing to the continued exposure of the eye to the air, or to the want of the lachrymal secretion—the only other causes which appear to have occurred to him—Magendie arrived at a conclusion the opposite of that just mentioned, and adopted the opinion that the phenomena 'depend upon an influence purely nervous,'[1] exerted by the *fifth nerve* upon the eye—'*an influence independent of the connection of the nerve with the spinal marrow*'[2]—*an influence proper to the nerve, which has not its source in the cerebro-spinal system*, and *which is even the more energetic the further we remove from that system to a certain distance*, of which the following is his proof: 'Alterations of nutrition in the eye are the less com-

[1] Anatomie des Systèmes Nerveux, &c., t. xi. p. 716.

[2] Journal de Physiologie, p. 304.

plete, the less rapid, *as we remove further from the point of branching* of the nerves of the fifth pair, and as we cut within the cranium, the fasciculus of origin the nearer to its insertion; finally, the section of the nerve on the margin of the fourth ventricle no longer produces any alteration in the state of the eye.'[1] On this view, there are plainly two positions advanced, viz: that the nerve does itself exert a proper and independent influence upon the nutrition of the eye, and that it is the section of the nerve which causes the exercise of that influence, or, to use his own words, which is the cause of the inflammation, &c. That the occurrence of the alterations in the eye, in the case in question, is not due to an influence exerted by the brain through the nerve, and that it must proceed from another cause, and that not dependent upon the connection between them, is manifest, since it is consequent upon the interruption of that connection; and therefore, if the nerve do possess the supposed influence, *it must be a proper and independent one;* but are we therefore to infer that the nerve does exert such an influence upon the organ? It appears to the writer (Alcock) that we cannot; for can we suppose that the nerve is endowed with a property to be displayed expressly under circumstances which, it is fair to say, were not contemplated in the establishment of natural laws, viz., in cases of mutilation?—or, *is it possible that a separate influence can exist in the nerve*, and increase in energy in proportion as the nerve is curtailed? for, the *nearer the section is made to the eye*, the more remarkable are the effects.[2] Or if any other proof that the nerve does not possess such an influence be wanting, can we suppose that it is possessed for the eye and not for the other parts to which the branches of the nerve are distributed? Why does not the inflammation forthwith assail the nostrils, the mouth, and cheeks, upon the mere section of the nerve as well as the eye?[3] Manifestly *because no such influence exists;* and indeed the data upon which it has been assumed, instead of proving the position, leave it precisely as it was; for inasmuch as the occurrence of the phenomena upon the section proves the existence of the influence of the nerve, in the same degree does the absence of the phenomena upon the section of

[1] Op. cit., *ibid.*

[2] Dr. Alcock appears to think that the *ratio ad absurdum* is applicable here, but we hope to show that Magendie, though not understanding *whence* the influence is derived, is nearer right than he is.

[3] It does, to a certain extent, as shown by his own quotation from Magendie and Dr. Alison.

the nerve" (we must here recollect that this second section is further back, nearer the medulla oblongata) "disprove it."

"But *was* the inflammation caused by the section of the nerve? This question, which certainly ought to have been determined satisfactorily before a theory had been founded upon the assumption, appears to the writer to have been decided too hastily in the affirmative. If the section was the cause, no sufficient reason can be assigned (?) why it should occasion inflammation in one part to which the nerve is distributed, and not in another—yet such is the case; the eye is the only part in which inflammation supervenes, either so uniformly or so quickly as to afford any ground for attributing the process to the section. In the second place, were the section the real and essential cause, it cannot be supposed either on the one hand that the non-essential circumstances could influence, or at all events, prevent the effect, or on the other that they could produce it. Now it will presently appear that both the one and the other may take place; and a comparison of Magendie's experiments and their results will alone suffice to show, that the real cause is to be sought elsewhere than in the section of the nerve. Magendie divided the nerve in three different situations; first, through the temporal fossa; secondly, within the cranium, between the Gasserian ganglion and the pons Varolii; and thirdly, at the margin of the fourth ventricle; and his own general account of the results, which has been already cited, is as follows: 'Those alterations in the nutrition of the eye are the *less complete*, *the less rapid*, as we *recede more from the point of branching* of the nerves of the fifth pair; and as we cut within the cranium, the fasciculus of origin the *nearer* to its insertion; finally, the section on the margin of the fourth ventricle no longer produces any alteration.' It is plain then that the nerve may be cut, and the changes in the eye ensue or not, according to circumstances to be yet explained. On the other hand, that effects similar in kind, if not equal in degree, may be produced by circumstances not essential to their production—according to the doctrine maintained, but incidentally associated with the supposed cause—that such effects may be produced by such circumstances when dissociated from the other and operating separately, the author (Alcock) feels justified in asserting from the result of some experiments lately made by himself, which lead to the conclusion that similar effects may be produced without the section of the nerve at all, and that an injury in the vicinity of the

orbit may excite them, though neither the trunk of the fifth itself, nor its ophthalmic division, has been divided. In endeavoring to determine the nerves of taste, he undertook the removal of the *ganglion of Meckel* from the dog. In order to accomplish this, it was necessary to displace the zygoma and the coronoid process of the jaw; he attempted it several times before he succeeded, and failed at different stages of the operation; but in almost every instance the *eye* of the *same side* became *bleared within the next two days.* The animal kept it nearly closed, a whitish puriform matter was discharged from it, in quantity proportioned to the case, which concreted between the lids, and the animal made no attempt to remove the matter or cleanse the eye; the affection of the eye was always proportioned to the violence done, and abated with the inflammation of the wound, *and in one of the instances in which the ganglion was removed, it actually produced opacity of the cornea, and ulceration in that structure,* which continued after the lapse of more than a month from the operation; yet most assuredly neither infra-orbital nor ophthalmic nerves had been divided. Thus if, on the one hand, the nerve" (meaning the fifth) "may be cut and the changes not ensue, on the other, it may be left uncut, and yet the changes may occur ..... From the preceding considerations it appears to the author necessary to infer, that the changes which supervene in the eye after the section of the fifth nerve in certain cases, *take place independently of the section* as the primary, immediate, or proper cause; for were it otherwise, it cannot be supposed either that the difference of half an inch to one side or the other, as regards the point of section, could so influence the cause as to prevent or allow these changes, or that they could occur, even in degree, without it.

"How, then," continues our author, "are the phenomena to be explained? It has been said by Magendie that they are less marked the more we recede from the point of branching of the nerve; but it is to be further observed, that as we recede from the point of branching of the nerve, we recede also from the orbit, the eye, and its appendages, and in our operation for the division of the nerve, we do less violence either in their vicinity or actually to them, until the operation is performed at such a distance from those parts that they are not involved in the injury inflicted. .....

"It would seem, then, that the *great violence* inflicted either in the vicinity of the eye, or actually to its appendages, constitutes the

primary and immediate cause of the alterations which took place in the eye in the experiments under consideration."[1]

We have quoted thus extensively from Dr. Alcock's paper, not merely because we think we see the interpretation of the phenomena which neither himself nor Magendie seems to have suspected, but more particularly because his account of these experiments, and also his reasoning upon them, appear to our mind to embody all the phenomena necessary to develop very fully the secretory function of the ganglionic system of nerves, and also to illustrate the *connections* between that system, as it exists in the eye and its appendages, and the cerebro-spinal system, in a most pertinent and striking manner. The very difficulties which he proposes, and the mystery with which he and Magendie both seem to invest the phenomena—the one attributing an inherent, independent power to the fifth pair, while the other denies its existence, only serve to bring the question under consideration more fully into a form of proposition approaching to that which logicians technically term the dilemma, and render it more apt for a ready and satisfactory solution.

Let us review, briefly, a few of the results of these experiments on the fifth nerve, and also some of the deductions of Magendie, with those of Dr. Alcock, in regard to them. With the results relating to the sensibility or motor power in the parts, we have nothing to do, but in those results which concern the alteration in the tissues of the organs to which the branches of the fifth are distributed, we are deeply interested.

It will be observed, then, that besides the loss of sensation, &c., "*other* changes supervene. The cornea of the eye of the side on which the section is made, twenty-four hours afterwards, begins to become opaque; after seventy-two hours, it is much more so, and in five or six days, it is as white as alabaster. On the second day, the conjunctiva becomes red, inflames and secretes a puriform matter. . . . Finally, the cornea ulcerates, and the humors of the eye escape, and the globe contracts into a small tubercle."

Mons. Magendie, in reasoning upon these phenomena, is careful to state, that these effects are not due to the *arrest* of the *lachrymal secretion, which also is one of the common results of the section*, or to the continued exposure of the eye to the air, and he further confirms

[1] Cyc'opedia of Anatomy and Physiology, by R. B. Todd, M. D.; article, Fifth Pair of Nerves, p. 312; B. Alcock, contributor.

the justice of his opinion by two independent experiments—first, the removal of the gland without these results, and secondly, a section of the seventh pair. He thus, apparently, fairly comes to the conclusion, that the section made upon the trunk and branches of the fifth pair is the *cause* of the changes in the tissues, and in the secretions of the eyeball; and becomes settled in the conviction, that in this nerve resides the controlling influence of the circulation of this organ. But upon making his sections further back, that is, nearer to the origin of the nerve at the fourth ventricle, although more of the nerve is cut off, or "curtailed," still the amount of the effect is diminished; he therefore comes to the conclusion, that this power, which, to his mind, undoubtedly exists in the fifth nerve, must be independent of the spinal marrow and the brain, that it must be an "*inherent power*" in the fifth nerve itself. His reviewer, Dr. Alcock, denies this theory, and accounts for the diminution in the results on receding from the eye, on the theory that as he receded from the eye, just so much was the mechanical local injury removed from the vicinity of that delicate organ, and hence the result would not be *expected* to be so marked. The explanation of these apparently mysterious results, and the conciliation of these very opposite opinions, we think are to be found in a more extended view of the subject, and in a comparison of the results of Magendie's experiments with the known results of certain other experiments made years previous, not with any view, however, to develop the functions of the fifth pair of nerves.

From the mere fact that they have been brought within a few pages' proximity to each other, the reader has doubtless been struck, ere this, with the remarkable similarity—indeed, identity—of the results subsisting between this series of experiments by Magendie, to determine the function of the fifth pair of cerebro-spinal nerves, and those performed nearly one hundred years before by Pourfour du Petit,[1] on the dog, to determine the function of the branches of the sympathetic nerve, again by Arneman,[2] and later by Dupuy,[3] upon the horse, and still later by Dr. John Reid,[4] on the dog, the cat, and the rabbit; all followed by the same uniform results, viz., congestion of the eye, opacity of the cornea, aberration in secretion, purulent discharge, ulceration, discharge of the contents of the globe, and generally, final destruction of the entire organ. Could

[1] Loc. cit., 1732.
[2] Loc. cit., 1789.
[3] Loc. cit., 1816.
[4] Loc. cit., 1839.

we ask a closer identity of results? When we scan Dr. Alcock's arguments against Magendie's theory a little closer, and analyze his own experiments, which he adduces to prove that Magendie has caused his results by the "*mechanical violence inflicted*," we find a still stronger corroboration of the opinion that all the results of Magendie's experiments which relate to nutrition and secretion, were of the same character and from the same source as those produced in the older series by Pourfour du Petit, Arneman, Dupuy, Reid, Molinelli, and others. "The author" (referring to himself) "feels *justified* in asserting, &c., from the result of some experiments lately made by himself, which lead to the conclusion that similar effects may be produced without the section of the nerve (fifth pair) at all, and that an injury in the vicinity of the orbit may excite them, though neither the trunk of the fifth itself, nor its ophthalmic division, has been divided. In endeavoring to determine the nerves of taste, *he undertook to remove the ganglion of Meckel from the dog.*" He failed in some of these operations, and in others succeeded, "*and in almost every instance, the eye of the same side became bleared within the next two days.*" A whitish puriform matter was discharged from the eye; "*and in one of the instances in which the ganglion was removed, it actually produced opacity of the cornea and ulceration in that structure.* . . . Yet, most assuredly, neither the infra-orbital nor ophthalmic nerves had been divided." In this last remark, we see plainly whence these changes can arise; this Meckel's ganglion, so incidentally and apparently unsuspectingly mentioned, is a ganglion of the sympathetic or secretory system of nerves—a centre of that controlling influence which we have seen presides over, directs, and superintends the nutrition and secretion in every vascular organ of the body—a centre, similar in its endowments and inherent peculiarities to the cervical ganglion experimented on by Pourfour du Petit, nearly a century before, with identical results. If there ever is any doubt remaining in relation to the ganglionic character of this spheno-palatine body (some have said it was only a mass of fat), that doubt must be at rest forever, for while Dr. Alcock's experiment has failed to controvert the statement of Magendie, that the fifth nerve possessed some inherent element for controlling the nutrition of the parts to which it is distributed, and rather establishes the reverse, it proves most satisfactorily that Meckel's ganglion is, *indeed*, a ganglion of the secretory system of nerves. It further proves that its branches, though not apparently distributed directly to the eye, are very important to the processes of nutrition

going on in that organ. But, it may be asked, if these aberrations of nutrition and secretion following the section of the fifth nerve *at certain points*, did not accrue from the mechanical violence done to the parts; if, as it appears, the escape from these results did not come from a connection being maintained with the medulla spinalis, how can the phenomena be explained without the admission of the theory advanced by Magendie, viz., that "a separate influence may exist in the fifth nerve, increasing in energy in proportion as the nerve is curtailed?" This brings us naturally to an important portion of our subject, viz., the consideration of the relations and connections subsisting between the trifacial of the cerebro-spinal and the ganglionic or secretory system of nerves, for it is in this region that we expect to illustrate more particularly some of the more striking features of that somewhat recently described function which results from these connections and relations—the excito-secretory.

That the fifth pair of nerves should be endowed with "a separate influence, increasing in energy in proportion as the nerve is curtailed," would, indeed, appear to any one, as it does to Dr. Alcock, a preposterous and paradoxical proposition, unworthy of any attempt at serious refutation; and, hence, he gives to it a simple but decided denial, and seeks the explanation of the phenomena elsewhere, viz., in the violence done to the parts concerned in the performance of the experiments. But to our mind, keeping constantly in view the whole train of phenomena here presented, and still giving due weight to the significance of the results of other experiments, performed years before to determine the function of a totally different portion of the nervous system (the sympathetic or secretory), the theory of Magendie is perfectly acceptable when he refers to "an influence residing in the nerve, and that it increases as the nerve is curtailed." The proposition is only preposterous when we fail to apply the key to their explanation, which key is impartial and unbiased observation and generalization.

The fifth pair, trifacial, or trigeminal nerves, is a pair of nerves of the cerebro-spinal system, arising, according to the most reliable authorities, from the medulla oblongata, near the region of the fourth ventricle. In its distribution, it is found displayed principally upon parts endowed with sensation, as the cutaneous surfaces of the face, side of the head, the eye, &c. &c., but in addition to these parts, we find that branches are sent to the tongue, lachrymal gland, mucous membrane of the nose, &c. And, also, that a portion of this trifacial nerve supplies branches to certain muscles

of the jaw, viz: the pterygoid, buccinator, masseter, and temporal. With these muscular or motor branches, we are not concerned in the present investigation, nor, indeed, with the many theories promulged by authors attributing various endowments of special sensation, as of hearing, olfaction,[1] vision,[2] &c., to the sensitive portion of the nerve, our interest being principally in its endowment of ordinary sensation, and the alleged control which it exerts over the nutrition of the parts to which it is distributed. In considering more closely the three divisions of the fifth pair of nerves, we find that the upper division, or ophthalmic nerve is given off from the superior part of the Gasserian ganglion, and as a short trunk proceeds towards the orbit, where it divides into three branches; the frontal, the lachrymal, and the nasal. The frontal branch goes to the cutaneous surfaces about the forehead and eyelid, &c., and by experiment and observation, is found to endow these parts with ordinary sensation; but the two remaining branches, viz: the lachrymal and the nasal, are principally distributed upon parts and surfaces, which, while they possess the common attribute of ordinary sensation, yet also perform acts calling for endowments not to be supplied from the resources of the cerebro-spinal system at all—endowments which are only found to be conveyed to any part by the distribution of *ganglionic* filaments in that part—we refer to the lachrymal gland, the conjunctiva and mucous membrane of the nose, all secretory surfaces,[3] to which these two latter branches of the ophthalmic are distributed. The secretory element, then, being necessary in the parts to which these branches are sent, in order that they may perform their proper function of secretion, we find placed in convenient juxtaposition with them a ganglionic centre of the secretory system, viz: the lenticular, or ciliary ganglion, which sends what is called its long root, to the nasal nerve, and thus supplies it with the secretory element. The lachrymal branch receives its secretory filaments from the carotid plexus through the several branches sent to the ophthalmic nerve previous to its division.[4]

The above arrangement we see carried out with regard to the

[1] Scarpa. De Auditu et Olfactu.

[2] Zinn. De differentia fabricæ oculi humani et brutorum.

[3] A gland is but a complex secretory surface. See Grant's Outlines of Comparative Anatomy, Owen's Lectures on Comparative Anatomy, and Carpenter's Comparative Physiology.

[4] Anatomist's Vade Mecum. Erasmus Wilson, p. 485.

other divisions of the trifacial nerve; thus, in the case of the superior maxillary, inasmuch as certain filaments from this division are to be distributed to secretory surfaces, as the buccal mucous membrane, the mucous membrane of the antrum, the mucous membrane of the floor of the nares and the palate,[1] we find that ere it proceeds to these parts, and even before giving off any of these filaments of distribution, it has incorporated with it, two very stout trunks from the ganglion previously mentioned, viz: Meckel's ganglion, or the spheno-palatine ganglion, and that afterwards the naso-palatine, or Cloquet's ganglion, affords it another supply for the secretory exigencies of the anterior portion of the mouth and lips. Then, again, when we come to consider the last great division of the trifacial, viz: the inferior maxillary nerve, we find, to a certain extent, the same character of distribution, consequently the same need for the secretory element, and just as certainly, the same collocation of a ganglionic centre, and the abundant supply therefrom of the required secretory influence.

We refer now particularly to its sensitive or internal trunk. This we find dividing into three branches, the gustatory, the inferior dental, and the anterior auricular, which are distributed to the teeth of the lower jaw and other sensitive parts, but also to several parts which are not only sensitive, but secretory as well; thus we find these various branches supply the tonsils, the mucous membrane of the fauces, the submaxillary gland and duct of Wharton, and the sublingual gland, while certain branches go to the meatus auditorius and the tympanum. Here the submaxillary ganglion serves as the magazine of supply, and that is reinforced probably by the considerable tributary filament, the chorda tympani, which runs along in the sheath of the gustatory, to join that ganglion at the submaxillary gland. The auricular nerve which supplies, in part, the mucous secretory surface of the internal meatus and the tympanum, is fitted for the secretory office by the branches it re-

[1] "Previously to their distribution, the dental nerves form a *plexus*" (this looks very much like they contained ganglionic filaments, the *peculiar trait* of which is to form *plexuses*), "the superior maxillary plexus, in the outer wall of the superior maxillary bone immediately above the alveolus. From this plexus, the filaments are given off which supply the pulps of the teeth, the gums, the mucous membrane of the floor of the nares, and the palate. Some *gangliform masses* have been described in connection with the plexus, one being over the canine, and another over the second molar tooth."—*Anatomist's Vade Mecum.* Erasmus Wilson, p. 442.

ceives[1] from the otic ganglion situated near the inner surface of the inferior maxillary nerve, immediately below the foramen ovale. The last, but at the same time the most important region in this connection, which we will refer to before attempting to explain the results of Mons. Magendie's experiments, is the interior of the globe of the eye itself. This portion of the being is, to all intents and purposes, an organism of itself, cut off and excluded from all channels of communication with the nervous centres, except those which enter its interior by the nerves which perforate the sclerotic coat. Yet its endowments are varied and complex; general sensation, special sensation, and muscular motion, with an exquisitely adjusted excito-motory correlation, as evinced by the contractions and dilatations of the pupil. In order to maintain these several functions, there are sent to this organism nerves severally endowed with each of the above functions. Thus for the special sense, of which it is the organ, we find the optic nerve; for ordinary sensation and for motion, and its excito-motory phenomena, branches of the fifth pair, and also branches of the third pair proceed towards its posterior wall, and finally enter it, conveying to the organ all those powers, both primary and subsidiary, necessary for the exercise of its peculiar function, vision. But the eye, besides being a delicately arranged apparatus of vision, is also a portion of a living organism—to a certain extent, as we have before said, a separate living organism itself, and besides æsthetic and motory endowments, it further requires to be maintained as a nutrient and secretory organ; its circulation, its metamorphosis of blood and tissues have all to be superintended and directed; the optic nerve, nor the fifth, nor yet again can the third pair answer the requirements of these peculiar processes. The *secretory* element is indispensable, and can only be supplied by the ganglionic or secretory system; without this element in its nervous organization, the eye would not be at any one moment in the status or condition in which it was the moment before. Its circulation would be paralyzed, its secretion and absorption would be null, stasis would be the result, the beautiful transparency of the cornea would be replaced by opacity, and ulceration, disintegration, and finally destruction of the entire organ most certainly ensue.[2]

[1] "The branches of communication are two or three filaments to the outer portion of the inferior maxillary nerve; one or two filaments to the auricular nerve, &c."—*Erasmus Wilson, op. cit.*, p 484.

[2] See results of experiments before cited.

How, then, is this ganglionic influence conveyed to the interior of the eyeball, and whence does it come? It probably enters along with the filaments of the fifth and the third nerve, and possibly also with the coats of the bloodvessels, but mainly with the nerves mentioned. It has two principal sources, viz: firstly, the carotid plexus, or the first cervical ganglion, and secondly, the ciliary ganglion.

As we have seen, the ophthalmic division of the fifth nerve, before entering the orbit, and while yet in the outer wall of the cavernous sinus, and "previously to its division, receives several filaments from the carotid plexus."[1] This plexus is formed, in great part, by branches derived from the superior cervical ganglion, and consequently when this ganglion is destroyed,[2] the eye becomes bloodshotten, and its circulation is modified. The branches of the fifth pair, which are intended to supply ordinary sensibility to the eye, separate from the rest of the nerve after it has received the filaments from the carotid plexus, and proceed towards the back part of the ball; the third pair (motor) having also received "one or two filaments from the cavernous plexus,"[3] enters the orbit and soon gives off a branch for the supply of the interior of the eyeball, which branch, like the sensitive filament from the ophthalmic, approaches the ball of the eye. Here these filaments destined for the ball enter the lenticular ganglion, and obtain a reinforcement of secretory filaments, and thus fully provided with the three kinds of influence necessary, they enter the globe of the eye to supply its delicate tissues, and preside over its various processes of sensation, motion, and nutrition.

In order to present more definitely the various ganglionic and cerebro-spinal connections so repeatedly discussed in the above paragraphs, we here transfer from a recent edition of *Wilson's Dissector*[4] the following illustration and references.

We are now prepared to examine the paradoxical assertion of Magendie, "that a separate influence resides in the fifth nerve, increasing in energy in proportion as the nerve is curtailed," or in other words, the more of the fifth nerve cut off from its connection

[1] Erasmus Wilson, op. citat., p. 439. London, 1844.

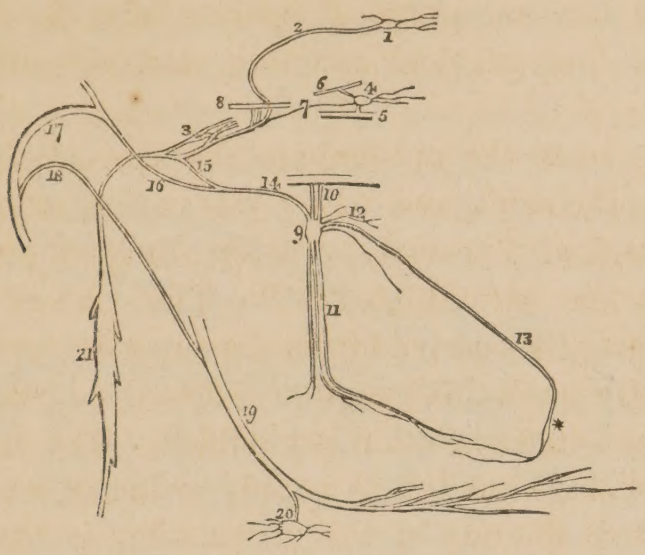
[2] As in experiments by Dupuy, Reid, and others, cited.

[3] Erasmus Wilson, op. citat., p. 433. London, 1844.

[4] Edited by William Hunt, M. D., Demonstrator of Anatomy in the University of Pennsylvania. Published by Blanchard & Lea. Philadelphia, 1856. Page 184, fig. 54.

with the brain and spinal centre, the less was the effect upon the circulation and nutrition of the eye; and when he made the section

Fig. 1.



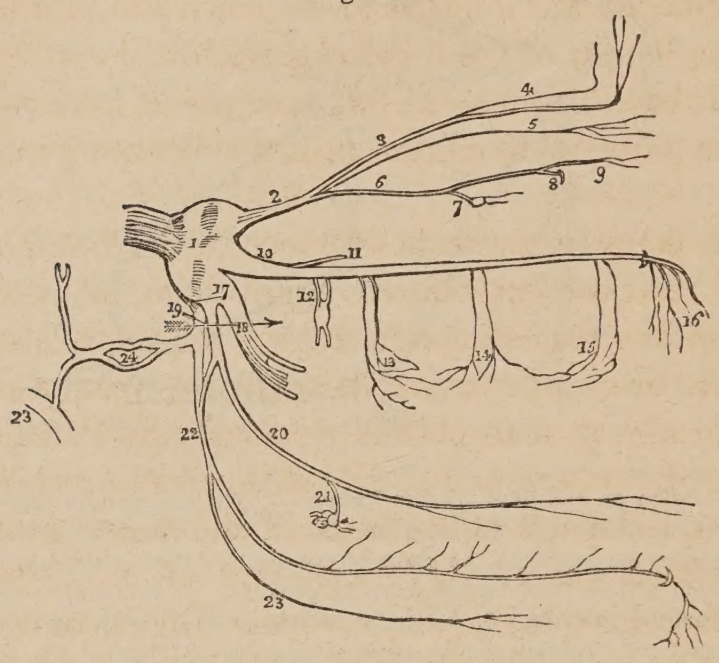
THE CRANIAL GANGLIA OF THE SYMPATHETIC NERVE.—1. The ganglion of Ribes. 2. The filament by which it communicates with the carotid plexus (3). 4. The ciliary or lenticular ganglion, giving off ciliary branches for the supply of the globe of the eye. 5. Part of the inferior division of the third nerve, receiving a short thick branch from the ganglion. 6. Part of the nasal nerve, receiving a longer branch from the ganglion. 7. A slender filament sent directly backwards from the ganglion to the sympathetic branches in the cavernous sinus. 8. Part of the sixth nerve in the cavernous sinus, receiving two branches from the carotid plexus. 9. Meckel's ganglion (spheno-palatine). 10. Its ascending branches, communicating with the superior maxillary nerve. 11. Its descending branches, the posterior palatine. 12. Its anterior branches, spheno-palatine or nasal. 13. The naso-palatine branch, one of the nasal branches. * The point where Cloquet imagined the naso-palatine ganglion to be situated. 14. The posterior branch of the ganglion, the Vidian nerve. 15. Its carotid branch, communicating with the carotid plexus. 16. Its petrosal branch, joining the angular bend of the facial nerve. 17. The facial nerve. 18. The chorda tympani nerve, which descends to join the gustatory nerve. 19. The gustatory nerve. 20. The submaxillary ganglion, receiving the chorda tympani nerve from the gustatory. 21. The superior cervical ganglion of the sympathetic.

as far back as the border of the fourth ventricle, thus cutting off the whole of the nerve, no perceptible effect on these processes followed, while all the parts to which the fifth nerve was distributed became paralyzed in both sensation and muscular motion. Dr. Alcock denies the existence of the influence above referred to. Of the two opinions, we decidedly adopt that expressed by Magendie. There is indeed an influence acting in the various sections of the nerve exactly in the manner which Magendie describes—an influence which Magendie attributed to "*some inherent power* in the nerve itself, independent of the brain or spinal marrow," but which we, with all due respect to the opinions of that great man, the father of experimental physiology, and deference to the reasoning of his distinguished reviewer, still feel compelled to assert, is

conveyed to certain branches of the fifth pair by virtue of their connections with the *ganglionic* or secretory system of nerves.

For the more ready apprehension of the subject, we place before the reader another one of the illustrations, with references, taken from the work above cited.[1]

Fig. 2.



THE BRANCHES OF THE FIFTH NERVE.—1. The Gasserian ganglion. 2. The ophthalmic nerve. 3. The frontal nerve. 4. Its supra-trochlear branch. 5. The lachrymal nerve. 6. The nasal nerve. 7. Its branch of communication with the ciliary ganglion. 8. The passage of the nerve through the anterior ethmoidal foramen. 9. The infra-trochlear nerve. 10. The superior maxillary nerve. 11. Its orbital branch. 12. The branches of communication with Meckel's ganglion. 13. The posterior dental branches. 14. Middle dental branches. 15. The anterior dental branches. 16. The infra-orbital branches. 17. The inferior maxillary nerve. 18. Its external or muscular division. 19. The internal division of the inferior maxillary nerve. The arrow marks the separation of these two divisions of the nerve by the external pterygoid muscle. 20. The gustatory nerve. 21. The branch of communication with the submaxillary ganglion. 22. The inferior dental nerve, arising by two roots. 23. Its mylo-hyoidean branch. 24. The auricular nerve. 25. Its branch of communication with the facial nerve.

As will be perceived, the above lignograph is a representation of the distribution of the branches of the fifth pair to the eye, the upper and lower jaw, with the teeth of each, and to the tongue, &c. &c., though the organs themselves are not here represented.

Now, Magendie found "that the alterations in the nutrition of the eye were *less complete* and *less rapid* as he receded from the point of branching of the fifth nerve;" and as he cut upon the ocular side of the point of branching, he found these changes to increase. Our explanation is the following: When the section was made anywhere between the point of junction of *secretory* fila-

[1] Wilson's Dissector, p. 177. Fig. 52.

ments with the nerves supplying the eye, then the nutrient function became disturbed, because the secretory influence passing from the ganglionic centre was interrupted, but as he receded with his sections towards the spinal origin of the fifth pair, he more and more avoided producing this interruption—that is, more of these ganglionic filaments were allowed to escape intact, and more of the secretory influence was allowed to be conveyed, until, making his section at the border of the fourth ventricle, they *all* escaped interruption, and the *entire amount* of the *ganglionic* influence was transmitted to the parts, while all the *sensory* and *motory* influences were cut off.[1]

There are many arguments which could be brought to sustain this view of the question, but we regard them as unnecessary. It is truly surprising that Magendie did not see the relation which the results of his own experiments bore to the results of those performed about ninety years (1732) previously by Pourfour du Petit, and still later by others, and the more especially as his own idea of an "inherent, independent influence of the nerve" groped so near to the truth, and was so very suggestive of it. It is even more surprising that his philosophic reviewer, Dr. Alcock, should have mistaken the true explanation, and was almost led to impeach the skill of the great experimental physiologist; but the one, intent upon the determination of the function of a special nerve, could not open his mind to general views and the records of physiology, while the other, intent upon refuting the assertions of his author, confined himself, too, to the special set of experiments under consideration, and failed to see what generalization would have made clear. Truly this was experiment proceeding blindly without her guide and mentor, observation.

We think that we may now venture to say that, besides the results afforded by the oft referred to experiments of Petit, Dupuy, Arneman, Brachet, and Reid, we can legitimately base our reasoning upon those also of Magendie, and that by this transfer of his results to their proper place, the data for our induction with regard to the phenomena of the secretory system have been somewhat increased. Observation here, then, has become experiment, for it will be admitted that observation has here converted a whole series

[1] Since completing the above rather prolonged examination of Magendie's experiments, we are gratified to find that M. Waller, of Bonn, has expressed a similar view of the same results.

of experiments, made by Magendie to determine the functions of the cerebro-spinal fifth pair, into a most valuable series, illustrating a totally different system, viz., the ganglionic or secretory system of nerves. What has been demonstrated in regard to the eye a little consideration will show is a principle pertaining to the distribution of the secretory nerves in all parts of the organism. In the eye, the main intents and purposes of whose organization is to subserve the function of vision, nutrition is only an auxiliary process, and consequently we find the secretory filaments and their function engrafted upon the senso-motory nerves supplying that organ; but there are certain other organs in which the primary object and end is nutrition and secretion; this is the case with the intestinal canal; it is the source of nutrition for the whole animal frame, and here we find the secretory system predominating, while the senso-motory, except in certain portions, is almost ignored and excluded. In the kidney, again, we find an organ entirely devoted to secretion, and entirely under the *immediate* superintendence of the ganglionic system. In close relation with both these apparatuses of nutrition and secretion, do we find a number of powerful ganglia, which send large and multitudinous filaments into the tissues of these organs. On the other hand, in the skin, we have, so to speak, an organ, one of whose main intents is to serve as a tactile and excitor surface to the entire organism; consequently, we find here the sensory nerves most abundant, and sensibility attaining its highest development—its culmination; but this cutaneous surface, besides being the tactile and excitor organ of the body, is also a secretory organ, a vast, complicated, and extended gland, the eliminations from which are highly important to the well being of the individual; consequently, do we also find, placed in convenient juxtaposition to the roots of all its nerves, and in connection with them, *secretory ganglia*, in order to supply the needed element for carrying on this process of secretion. We refer to the vertebral sympathetic ganglia, which doubtless are intended to supply the secretory function to the cutaneous surface; *how* this is done, we are aware, has not as yet been clearly and fully explained, whether by engraftment of filaments upon the sensory nerves, as shown to be the case in the nerves of the eye, or by admixture with the middle coats of the arteries (the most current opinion), but the fact is conceded that such an element is necessary to the circulation of parts *everywhere*, and these ganglia are the most probable sources from which that element is supplied. With the examination of the

above pertinent facts, we terminate our discussion of the secretory system of nerves; others, having perhaps a more direct bearing upon our main question, will be adduced hereafter to the further development and description of the excito-secretory system.

THE EXCITO-SECRETORY FUNCTION OF THE NERVOUS SYSTEM.

In the foregoing examination, we have endeavored to present certain allied facts pertaining to the functions of the two grand divisions of the nervous system, the cerebro-spinal and the secretory, in such a manner as we have deemed best calculated to favor the admission of the deductions contained in the succeeding portion of this essay. We have seen that to the ganglionic system, and to this system alone, are confided all those important and mysterious processes which pertain to nutrition and secretion, or, in the words of Bichat, "those thousand secret operations of a living body."[1] It presides over all our internal chemico-vital actions, superintending and directing all blood-changing processes, and instigating all metamorphoses occurring in the intimate structure of the animal tissues. It is the system for the internal and individual wants of the organism, and its possession enables the being to sustain an independent and individual existence, carrying on, to a certain extent, all strictly organic actions, without the aid of external influences. In corroboration of this view of the subject, we here insert a synopsis of the views of Dr. Davey, copied in the *American Journal of Medical Sciences* from the *London Lancet* of June 25, 1853.

"Dr. Davey read a paper on this subject before the Medical Society of London, the principal object of which was to prove the independency of the organic nervous system, and, what is more, the dependency of the integrity of the cerebro-spinal system in common with all the organism, on it. To prove his position, Dr. Davey brought forward a variety of facts, more or less startling, and these, selected with much apparent care, seemed to tell much in favor of the physiological views insisted on. After some preliminary remarks, intended to show the unsatisfactory and contradictory opinions expressed by our most popular writers on medicine

[1] Op. citat.

(physiology), viz., Wagner, Todd and Bowman, Carpenter, and others, concerning the ganglionic nervous system, he affirmed, on the authority of many good names, that the ganglia of the sympathetic nerve are those parts first formed in the fœtus, and that this same fact obtains equally, it was premised, through the whole kingdom. The early organism of birds was referred to in confirmation of that opinion, which assigns to the solar ganglion and its dependencies an existence anterior to any other part of the animal fabric. Especial reference was made to the two monstrosities recorded by Mr. Lawrence and Dr. Marshall Hall. The first of these, it is known, was born without a brain, but with the spinal cord complete; but the second, still more wonderful, was born without either a brain or a spinal cord. Dr. Davey argued that if, in the latter instance, the functions of secretion, absorption, &c., were duly and efficiently executed or performed without any aid from a cerebro-spinal system, then was this latter in no instance either requisite or necessary in any way to the integrity of such functions in the animal economy. The ganglionic nervous system, said he, is perfect at birth, and its functions are also perfect; this is completely organized, whilst the brain is nothing more than a mere pulpy mass, without any kind of function or use to the individual in possession of the same; the one is in active and increasing operation, the other is but a blank, doing nothing, useless; the ganglionic nervous system executes its function instinctively, whereas the brain, if not the spinal cord, requires time and experience and direction ere it perform its functions, either for good or for evil. Dr. Davey compared the monstrosity of Dr. M. Hall, organically considered, to the lower classes of animal life, the medusariæ; these, he said, performed functions of an instinctive and preservative character, executed those functions only which are strictly vital, such as secretion, absorption, nutrition, and so on; and therefore was it to be inferred, and most fairly and logically, that these same animals were possessed of a sympathetic nervous system and none other; the nervous organism of both the amyencephalous monster and the zoophyte was precisely similar, and their animal functions were on a par. As a further illustration of the opinions advocated, he cited some rare examples of vivisections performed by himself with the view of testing anatomically the relative importance of the ganglionic and cerebro-spinal nervous centres. It was shown that in frogs and fish both the brain and spinal cord may be destroyed, and that, nevertheless, all the

strictly vital functions will continue to be carried on as before. These animals, it was observed, offered peculiar facilities for the performance of such experiments, from the peculiarity of their respiratory apparatus; but, added the author, you have only to establish an artificial respiratory process or function in the higher order of animals, *i. e.*, those who breathe normally with the aid of a complex set of nerves and muscles, for that which is purely natural, and then may the spinal cord and brain be destroyed with an almost equal impunity, so far as the said vital acts are concerned in them. The phenomena of sleep and disease were referred to as offering strong and corroborative evidence of the physiological opinions insisted on; and, in so far as the latter is concerned, Dr. Davey mentioned that the wards of any lunatic asylum would afford many instances of individuals who were reduced to a mere vegetative or organic existence by disorder affecting the brain and spinal cord; such patients, he said, lived oftentimes many years with their cerebro-spinal organism so disorganized as to be perfectly useless to them; unconscious, without feeling, emotion, or desire, void of thought, without hope, joy, or passion, lost to all normal sensation, or, perhaps, without feeling of any kind, and incapable of only the most imperfect motive power, enfeebled, paralytic, they nevertheless digest, secrete, absorb, in a word, carry on, year by year, the strictly vital functions, exactly as the malorganized fœtus does; exactly as the frog or fish, deprived of the brain and spinal cord, did; and exactly as the polypus is in the habit of doing. He then referred the Society to the experiments of Sir B. Brodie, performed many years since, for the purpose of proving that those nerves having a cerebro-spinal origin had no kind of influence on the reparation of injuries, and so on. Frogs, guinea pigs, and dogs, were the subjects of Sir B. Brodie's experiments; and it was found that the destruction even of the lumbar spinal cord, much less that of the crural and sciatic nerves, neither retarded nor impaired, in any way, the reparative process in the lower extremities;[1] thus, wounds and fractures made in the limbs so deprived of cerebro-spinal nervous influence healed and united as readily and completely as under all ordinary circumstances. Dr. Davey explains the facts recorded by Sir B. Brodie by saying that the ganglionic nervous power was necessarily left intact, and

[1] The more recent experiments of Brown-Séquard only corroborate these results of Sir Benjamin Brodie's experiments.

this it was which caused the wounds to heal and the fractures to unite, and insisted on it that, although great and serious injuries to the brain and cord were borne with impunity, and for the reasons above stated, yet were such altogether impossible in so far as the solar ganglion and its dependencies were concerned. It was very truly said that a comparatively feeble blow on the epigastrium over the solar ganglion would destroy life, and that it was a very common thing among boys to suffer greatly from slight and accidental blows taking effect on the pit of the stomach; and the great danger of physical violence, even in a slight degree, to the epigastrium was well known to the prize-fighting gentry, who forbade the combatants to strike below the sternum; and if, as the author asserts, the solar ganglion be the seat of life, the *locale* of the *impetum faciens* of old writers, the irritability, the motions without force, of Haller, then can we easily account for the facts just cited."[1]

From a consideration of the facts in relation to the monstrosities here adduced, and also from the analogies to be found in the animal kingdom and in pathological records, also referred to, we find that an independent existence can be maintained under the *sole* influence of the secretory system of nerves. But the human being, in its extra-uterine life, and also most of the lower animals, are not mere vegetative existences, but organisms, maintaining *relations* with the external world. In the normal condition, there are no independent entities among the higher classes. For, maintaining external relations, the being is endowed, as we have seen, with a nervous system of relation, which is the cerebro-spinal, the other grand division of the nervous system. This cerebro-spinal system has been subdivided into two portions, viz., the nerves of sensation and those presiding over muscular action. A *relation* has been discovered to subsist between these two portions of the nervous system, by virtue of which the sensory nerves have been found to act as excitors to the motory; and hence this system has been termed by Dr. Marshall Hall the *excito-motory* system of nerves. Now, as we hope more fully to set forth in the present discussion, these same sensory nerves are not only excitors to the *motory* system, but, under certain circumstances, most of them sustain an analogous relation to the *secretory* nerves, exciting them, and modifying their action, dimi-

[1] On the Physiological Uses of the Ganglionic Nervous System, American Journal of Medical Sciences, vol. xxvi. p. 457.

nishing, increasing, and altering the secretions, according to the extent and character of the excitation applied. It will be our object, then, to show that the sensory nerves, or, at least, some of them, sustain to the other two portions of the nervous system a *double* relation: first, excitors to the motory system, giving rise to the excito-motory system described by Dr. Marshall Hall in 1837; and,

Secondly, excitors to the *secretory* system, resulting in the *excito-secretory* system, enunciated first in this country in the year 1850,[1] and which second system Dr. Marshall Hall did not appear anywhere to recognize until the present year, 1857.[2]

In the establishment of our proposition of the excito-secretory function of the nervous system, we will present and discuss certain phenomena of the animal economy, which we think will answer well our purposes of illustration.

We have said that the cutaneous sensitive nerves are the excitors to the secretory system as well as to the motory. It has long been observed that there exists a well-marked correlation between the cutaneous surface without and the secretory surfaces within, and that the action of these organs is influenced in a marked degree by impressions made upon the external surface. The sudden exposure of the body to a cold atmosphere, or to a cold stream of water, it is well known, will increase the urinary secretion.

These phenomena have been variously explained. One of these explanations is, that there subsists an antagonism between the cutaneous surface and the secretory surfaces of the kidney, or the bowels, as the case may be. This doctrine of antagonism we regard as entirely unphilosophical, whether applied to the kidney, to the mucous surface of the bowels, or to any other portion of the animal organism. There is no such principle, in our humble opinion, as antagonism to be recognized in any of the operations of nature in her conduct of the vital processes, but a beautiful correlation and reciprocity are everywhere manifest in her economy.

[1] An Essay on the Influence of Dentition in producing Disease. By Henry F. Campbell, M. D., Demonstrator of Anatomy in the Medical College of Georgia.—*Southern Medical and Surgical Journal*, vol. vi., June, 1850.

We deem it proper here to state that all reference, either by note or in the text, to the previous publications of the author of this essay, were excluded from the manuscript presented to the committee; these annotations have been made subsequently to the award of the prize by special permission.

[2] London Lancet, March, 1857, Amer. ed.

Nor yet again can we justly account for these sequences upon the theory of revulsion, or a driving in of the blood upon the secretory organ. The real explanation is far more simple, and far more in accordance with the recognized principles of action in the nervous system. Under favorable circumstances, we irritate an excitor nerve and we stimulate muscular contractions, evidencing the existence of the excito-motory function. Now, under the circumstances above related, the excitor or sensitive nerves, having received an appropriate stimulus, excite, through the medium of the spinal centres, the action of those ganglia and filaments dominating the secretory organs in question; they control, as we have seen, their circulation; they preside over their secretion, and thus stimulated, they are excited to modify the circulation and the secretion. So far, this is a normal act, the result of that ordained and wholesome correlation established between these two portions of the organism through these two systems of nerves, the sensory and the secretory; but, should the excitation be unusually strong, amounting to what is popularly termed a "shock," or too prolonged, we find the secretory system acting unduly, and this action is then carried to an abnormal extent; the *dynamic* act so modifies the circulation that secretion becomes aberrated, or even arrested, and, perhaps, a change in the condition of the tissue from altered nutrition may result. Dr. Marshall Hall thus remarks, in his recent article[1] upon this subject: "A partial keen current of air, falling on *any* susceptible portion of the skin, may induce inflammation in any susceptible internal organ. An extensive burn or scald is apt to induce pneumonia."

It is in this way, then, viz., by the doctrine of the excito-secretory function of the nerves, that the above familiar, though, until a few years past, mysterious phenomena, have received their interpretation. But in order to study the excito-secretory system in its most definite and obvious relations, it will be necessary to select some portion of this system wherein a single excitor-nerve will be found to exercise its influence over an extended region, becoming productive of a diversity of results. We have already examined somewhat *in extenso* the distribution and connections of the fifth pair of nerves; we now select this portion of the nervous system as the most suitable excitor, the discussion of whose connections and phy-

[1] London Lancet, March, 1857, American edition.

siological relations, upon which we may illustrate the principle of excito-secretory action. We have seen that in its distribution it is displayed upon parts endowed with the most exquisite sensibility; that its connections with the secretory system are most intimate and abundant, a portion of the ganglionic system being engrafted upon it; and that, finally, in its central attachment, it is found implanted into that portion of the cerebro-spinal axis, which is generally conceded, and which the recent experiments of M. Bernard have demonstrated to exercise a more extensive influence over the vital processes of the organism than any other one portion, viz., the medulla oblongata.[1] This fifth nerve thus centrally connected, will be recollected to send certain filaments to the sensitive parts about the eye, certain others to the teeth, and also sensitive branches to the head and face.

What, then, are some of the phenomena occurring in the region of this nerve which are found to illustrate the function of excito-secretion? We think that the instances are varied and abundant. First, then, in regard to the eye particularly: under certain circumstances, the sensitive conjunctival surface of the ocular globe is exposed to a sudden draft of air, or to some more mechanical irritant. The first effect occurring from this exposure is, an immediate increase in the secretion of the lachrymal gland. This may continue, or it may be entirely arrested after continuing for a time. Secondly, the eye becomes perhaps dry, or it may become congested and secrete a puriform fluid, which, drying, closes the lids; or it may become entirely *bloodshotten* or *ecchymosed*, and in very favorable conditions, ulceration and even opacity of the cornea may result from this "taking cold." This is a condition of the parts, though arrived at much more gradually, which we find resulting from the experiments so repeatedly referred to in this paper, and our explanation of them is, that the sensitive fifth nerve becomes excitor through the spinal centre, to the modifications in the circulation, secretion, and nutrition of the eyeball, which acts are under the immediate reign of the ganglionic system. We can observe the same character of phenomena in the secretory lining membrane of the nostril; and also the same exposure to cold may, through the

[1] "Which last (the medulla oblongata) may no doubt be considered to be intermediate between the ganglionic and spinal systems, and partaking to some extent in the attributes of both."—Prize Essay on the Arterial Circulation in its Physiology and Chief Pathological Relations. By Henry Hartshorne, M. D.—*Transactions of Amer. Med. Association*, vol. ix.

fifth nerve, or other sensitive nerves, excite modified circulation in the fauces and pharynx through the secretory or mixed branches, which, together with the pharyngeal plexus, control the circulation of those mucous surfaces.

We will now refer to another form of irritation, and more local, but attended by almost identical results. How much a subject of every day observation has it become, that certain irritations in the buccal cavity are competent to affect the circulation of the eye! A few months since, we were in attendance upon a case wherein an eye which had previously been operated upon; after entire immunity from disease of every kind, became first slightly affected with linear congestion, the lachrymal secretion was greatly increased, then it became painful and bloodshotten, with slight ulcerations upon the cornea. This condition had continued for over a month, when, at the suggestion of a distinguished friend,[1] a *carious tooth* was extracted from the upper jaw of the side corresponding to the affected eye. The result was most marked and satisfactory; the pain, the flow of tears, and the congestion rapidly subsided, the parts regained their natural state, and the patient was entirely relieved. To trace the nervous connections, and to give the *rationale* of the above phenomena, is scarcely necessary at this stage of our discussion. Suffice it to say, that the dental irritation was here propagated to the spinal centre giving origin to the fifth nerve, and was then reflected upon the eye, lachrymal gland, &c., through the ganglia and filaments of the secretory system, controlling the nutritive and secretory processes of the eye.

In a consideration of this relation of the teeth to the sensory or excitor branches of the trifacial, and through them to the spinal marrow, and thence to the entire secretory system, is to be found nearly all that is necessary for the full portrayal of the excito-secretory system. For in the phenomena which sometimes result from these relations under peculiar circumstances, are to be found illustrations of almost every character and degree of modified secretion and nutrition. Let us, as has been done by us on former occasions,[2] here examine the varied phenomena of that period of in-

[1] Prof. Paul F. Eve, of Nashville, Tenn.

[2] See Essay, above cited, on the "Influence of Dentition in producing Disease."—*Southern Medical and Surgical Journal*, June, 1850.

Secondly. Article on "Sympathetic Nerve in Reflex Phenomena." By Henry F. Campbell, of Georgia.—*Transactions of American Medical Association*, vol. vi., May, 1853.

Thirdly. A letter to Dr. Marshall Hall, of London, entitled, "A Claim of Priority

fantine existence ordinarily termed the process of dentition. At this time the growing teeth begin to press upon the surrounding parts, which parts, and the teeth themselves, are supplied by the filaments from the fifth pair of nerves; the gums become sensitive, evincing great *local* irritation. Besides this local irritation, there are very generally other, and some of them much graver, affections attending the process of dentition, many of them, plainly, well-marked instances of aberration in secretion and nutrition. Thus the eye becomes lachrymose and congested, the Schneiderian membrane is also congested, and pours out an abundant secretion; the secretion of the intestinal mucous membrane is altered and increased to such an extent as to produce "the diarrhœa of teething," or cholera infantum.

In the discussion of these affections we do not wish here to occupy much space, as they have been fully, and, we think, rationally explained elsewhere.[1] Another class of affections, however, which attend the period of dentition, have never elsewhere been satisfactorily accounted for, nor their etiological connection with this process clearly made out; all admit that they are *concomitants* of dentition, but no one has ever explained *how* they may be the *results* of that process of evolution. We refer to those troublesome cutaneous eruptions so common among teething children. That they have a connection with this process, their popular name will plainly indicate, for some of them are called "tooth rashes" in common parlance. These eruptions, as is well known, vary much in character and degree, the milder being a mere roseate suffusion, while others assume the more refractory forms of vesiculæ, papulæ, squamæ, &c. &c., which are apt to continue during the whole period of teething.

Now, for these concomitants of dentition, there had never been presented any rational and satisfactory explanation, until they were referred to as illustrating the doctrine of excito-secretory action in 1850.[2] A comprehension of this doctrine affords to them a ready interpretation by referring them to the modified action of the secre-

in the Discovery and Naming of the Excito-secretory System of Nerves." By Henry Fraser Campbell, M. D., Member of the American Medical Association, &c. &c.

The above letter has been transmitted to the *London Lancet* for publication, and was published in this country in the *Southern Medical and Surgical Journal*, April, 1857. This claim was laid before the Association at its last meeting in May, 1857.

[1] Essay above cited. [2] Loc. citat.

tory system controlling the capillary circulation of the cutaneous surface, which modification is excited through the dental filaments of the fifth pair, the spinal marrow, and that portion of the ganglionic system above referred to.

The verification of the above view of the influence of these connections, and also of the effect of the local irritation, we ask leave here to adduce an observation which we are not aware has been recorded elsewhere. It is generally admitted that at the termination of the period of dentition, that is, when the child has acquired all its teeth, the cutaneous eruption, of whatever nature it may have been, subsides, and the skin resumes its natural condition, the patient not again being liable to its return. This, according to our observation, is generally, but not invariably, the case. We have observed certain instances in which the eruption had subsided for several years, when on the advent of the *second* dentition it came out with almost its former violence and inveteracy, not subsiding until the *second* period was entirely completed. So frequent has this return of the eruption been a subject of remark with us, that we now seldom encourage parents to expect permanent relief for their children, affected with these eruptions, until after the completion of the *second dentition.* Again: we find that children who have suffered severely during the period of dentition, are very liable to become affected with *dropsy*, this latter affection frequently presenting itself as the termination of the above cases. Since the announcement of the excito-secretory function of the nervous system, these cutaneous eruptions and dropsical affections which occur during dentition, in our opinion, need no extended and elaborate explanation. We deem it, however, proper to refer to the significant and most apposite fact, that when Dupuy extirpated the superior cervical ganglia in horses, "there resulted an *eruption over the whole cutaneous surface*, with *emaciation* and an *œdematous state of the limbs;*" may we not trace the cause of these analogous states occurring in dentition, to the prolonged aggression made by the dental irritation through the fifth nerve upon those secretory centres which control the capillary circulation of the cutaneous surface.

We are aware that the above phenomena, indicating embarrassed or aberrated action in the secretory system of nerves, might receive an explanation in the fact, that during this period several of the important emunctories of the system, as the liver and the kidney, suffer an arrest, or at least a modification in their eliminatory functions; but we will not contend here for the difference in the value

of these two opinions; either one of them can only rationally explain the phenomena by invoking the aid of the excito-secretory action originated by the irritation caused in the branches of the trifacial during the evolution of the teeth.

The *urinary secretion* is much influenced throughout the period of dentition. "Hunter,[1] and afterwards Underwood,"[2] says Dr. Laycock,[3] "remarked the connection between the teeth and the kidney and bladder in children; the growth of the former being accompanied with increased flow of urine, symptoms of gonorrhœa, and of stone in the bladder, and involuntary micturition. Mr. Bingham corroborates these observations," &c. At an early period of our connection with the study of medicine, we were led to investigate the relation which the process of dentition bore to this particular set of concomitants, and in the consideration of these relations were first traced out those connections between the cerebro-spinal *excitor* nerves and the ganglionic secretory nerves which constitute the basis of the excito-secretory function in every portion of the organism. Our observation, then, led us to the opinion that this increase of renal secretion was caused by *reflected peripheral* irritation from the growing teeth upon the dental branches of the fifth pair, which irritation being transmitted to the spinal centre giving origin to this sensitive nerve, rendered it an excitor to the secretion of the kidneys through the ganglionic system presiding over that particular function. A more thorough investigation of the anatomical relations of the trifacial, and especially of its final central connection with the cerebro-spinal axis, have only served to strengthen the above convictions, and while placing our *observed facts* in philosophical relation with some of the recent experiments of M. Claude Bernard, of Paris,[4] we are more fully convinced of their significance. Dr. Alcock[5] thus traces the trunk of the trifacial from the surface of the crus cerebelli to its real origin: "The course of the larger packet" (which is the sensitive) "is also beneath and before that of the lesser, and hence in the usual mode of dissection, in which the brain is reversed, it presents itself first.

[1] The Natural History of the Human Teeth, p. 234.

[2] On Diseases of Children. Ninth edition, edited by Dr. Marshall Hall; p. 252. London, 1835.

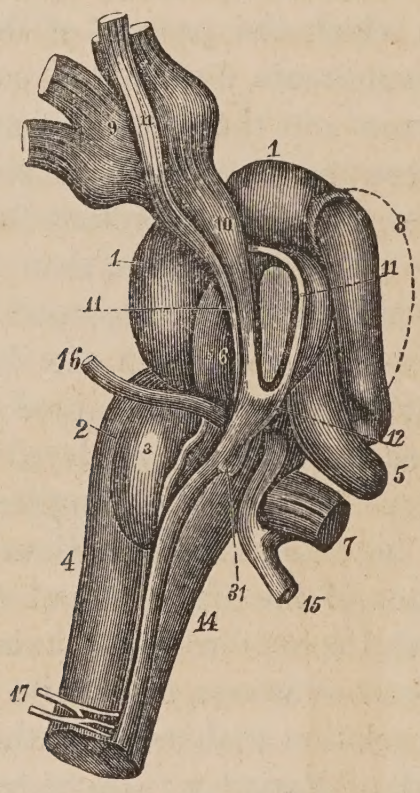
[3] Essay on Hysteria, p. 86, American edition. Philadelphia, 1840.

[4] *Vide* Leçons de Physiologie. Paris, 1854 and 1855.

[5] Cyclopedia of Anatomy and Physiology, vol. xi. p. 271, art. Fifth Pair of Nerves.

Its direction is backwards, downwards, and inwards, towards the upper extremity of the spinal bulb; . . . . it is then situate in the angle formed by the three peduncles of the cerebellum at their junction with the hemisphere; behind the middle, beneath the superior, and above the inferior, and before—or in common language, *beneath the floor of the fourth ventricle.*" He further quotes Sœmerring,[1] that "it appears to arise almost *from the very floor of the fourth ventricle.*" The following lignograph, No. 140 *Todd's Cyclopedia of Anatomy and Physiology*, will more fully illustrate the central connection of the fifth pair.

Fig. 3.



Lateral View of the Pons, Spinal Bulb, and Course of the Fifth Nerve in Man.—1. Pons Varolii. 2. Spinal bulb. 3. Olivary body. 4. Spinal cord. 5. Superior peduncle of cerebellum. 6. Cut surfaces of middle cerebellum. 7. Inferior peduncle of cerebellum. 8. Cut surface of crus cerebri. 9. Ganglion of fifth nerve reversed. 10. Ganglionic portion of the nerve. 11. Non-ganglionic portion of fifth nerve. 11′. Roots of non-ganglionic portion. 12. Eminence at the insertion of both portions of the fifth nerve. 13. Fasciculus to anterior column of spinal cord. 14. Fasciculus to posterior column. 15. Auditory nerve. 16. Portio dura. 17. Posterior roots of superior cervical nerves.

"I have adopted," says Erasmus Wilson,[2] "the origin of this nerve given by Dr. Alcock, of Dublin, in the *Cyclopedia of Anatomy*

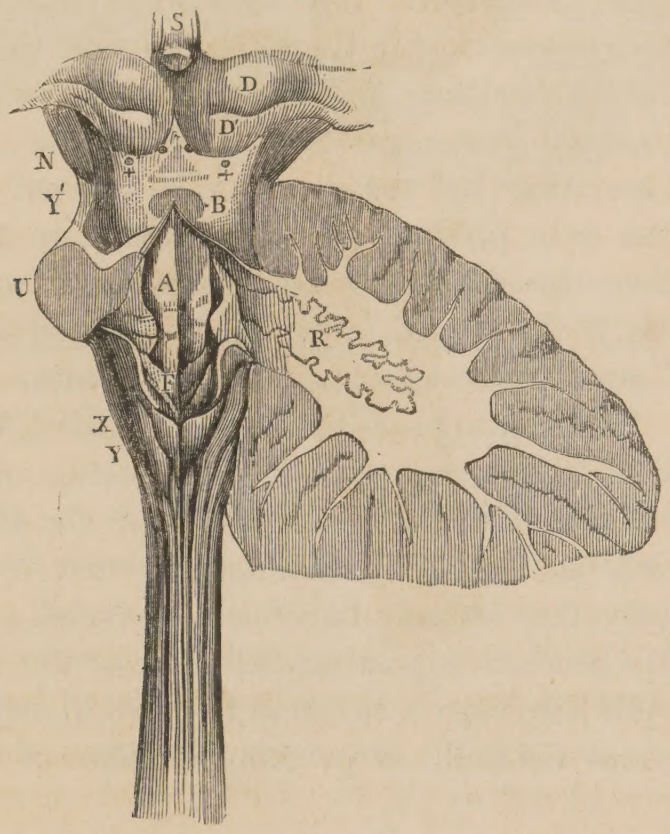
[1] De Corpori Humani Fabrica. 1798.

[2] Dissector's Manual of Practical and Surgical Anatomy. Second edition. London, 1853. P. 341, note.

and Physiology, as the result of his dissections. Mr. Mayo also traces the anterior root of the nerve to a similar origin."

We also here adduce the high authority of Dr. R. B. Todd[1] in relation to the connection of the trifacial with the floor of the fourth ventricle. "The ordinary columns are seen distinctly in their ascent to the brain *in the fourth ventricle*, as two cylinders (A, F, Fig. 4), *which form the floor of that cavity*. . . . . We here see distinctly that these columns" (which form the floor of the fourth ventricle) "are the source of origin of these nerves (the seventh pair), and no doubt they are equally so of all the nerves which are connected with the medulla oblongata, namely, the *fifth pair*, the eighth, the ninth, and probably also the sixth." The cut used by him is taken from Foville, and we here introduce it.

Fig. 4.



Posterior View of the Medulla Oblongata, with Mesocephale and part of Cerebellum of an Infant.—S. Pineal gland. D. Nates. D'. Testes. ++. Points of emergence of fourth pair of nerves. Y. Posterior pyramids. X. Restiform columns. A, F. Floor of the fourth ventricle, formed by the olivary columns, the fissure between which is the calamus scriptorius. Y'. Posterior surface of mesocephale. B. Valve of Vieussens. N. Anterior surface of crus cerebri. R. Corpus dentatum or rhomboideum.

Some time in 1852 (so far as we can ascertain by reference to records at hand), Mons. C. Bernard, of Paris, performed certain

[1] Descriptive and Physiological Anatomy of the Brain and Spinal Cord and Ganglions, &c., p. 177. London, 1845.

experiments to determine the influence of the galvanism of certain nerves upon the secretory functions of various organs. Having abandoned these, he next instituted others, which more recently we find clearly and satisfactorily illustrated in his lectures delivered at the College of France during the sessions of 1854 and 1855, and published, Paris, 1855 and 1856.[1] These brilliant experiments have won for M. Bernard a well-earned and enduring fame, and have done much towards the advancement of physiological science.

"We find," says a recent writer,[2] "as might be expected, minute details regarding the mode in which Bernard performs his celebrated experiment of inducing *artificial diabetes* by pricking a certain point of the *medulla oblongata* either of a herbivorous or a carnivorous animal; but, until we read these lectures, we were not aware that he had extended his experiment in the manner described in the following paragraph: 'When we prick the mesial line of the floor of the fourth ventricle in the exact centre of the space between the origins of the auditory and pneumogastric nerves, we, at the same time, produce an exaggeration of the hepatic (saccharine) and of the renal secretions; if the puncture be effected a little higher, we very often only produce an augmentation in the quantity of the urine, when this frequently becomes charged with albuminous matters, while if the puncture be below the indicated point, the discharge of sugar alone is observed, and the urine remains turbid and scanty. Hence it appears that we may distinguish two points, of which the inferior corresponds to the secretion of the liver, and the superior to that of the kidneys. As, however, these two points are very near to each other, it often happens that, if the instrument enters obliquely, they are simultaneously wounded, and the animal's urine not only becomes superabundant, but, at the same time, saccharine.'" We here copy a cut from Bernard, showing the relation of the parts, and the point of pricking the floor of the fourth ventricle.

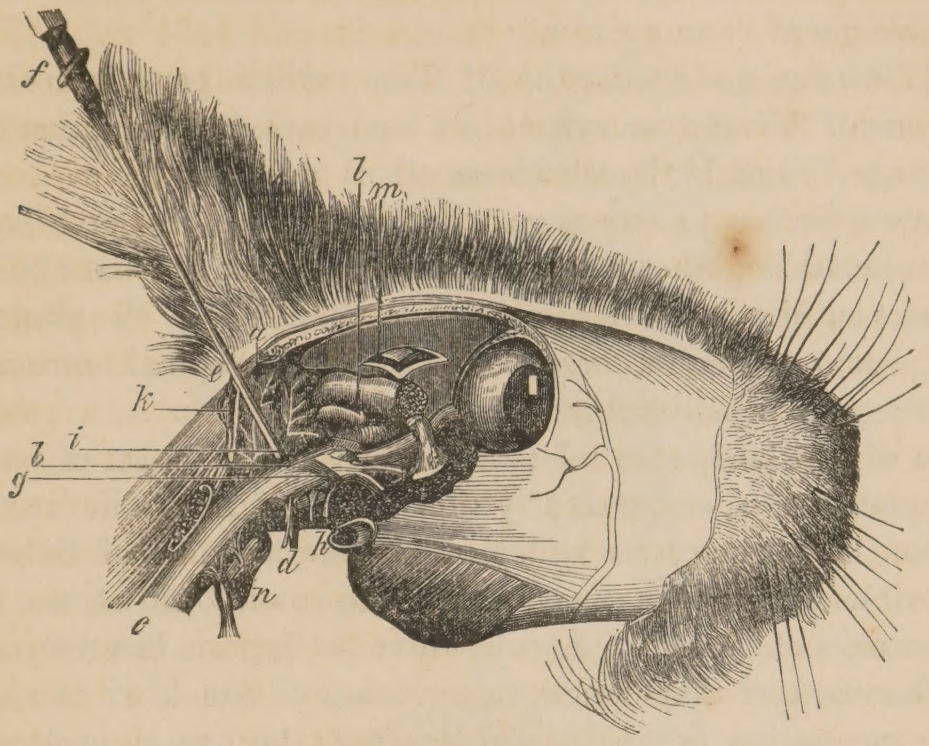
It will be seen, by examination of the above figure, that the place indicated for introducing the point, *i*, of the piercing instrument, *f*, in order to increase the secretion of urine, and to change its character, is very near to the implantation of the root of the fifth pair of nerves, *g*, in the following figure. Hence, we may fairly say that the above operation, performed, as it appears from

[1] Leçons de Physiologie Expérimentale, &c.

[2] British and Foreign Medico-Chirurgical Review, No. xxxvii., Jan., 1857, p. 32.

M. Claude Bernard's work,[1] on the 13th of February, 1855, proves *experimentally* that irritation made in a spinal centre is competent

Fig. 5.



Section of a Rabbit's Head to show the Direction of the Perforation. *a.* Cerebellum. *b.* Origin of the seventh pair of nerves. *c.* Spinal marrow. *d.* Origin of the pneumogastric nerve. *e.* Orifice by which the instrument enters the cranium. *f.* Instrument. *g.* Fifth pair of nerves. *h.* Auditory canal. *i.* Extremity of the instrument reaching the medulla after traversing the cerebellum. *k.* Occipital venous sinus. *l.* Tubercula quadrigemina. *m.* Cerebrum. *n.* Section of the atlas.

to excite and to modify the secretory function of the abdominal viscera, which function is exercised under the reign of the ganglionic system, the parts in which it goes on being only intermediately connected with that spinal centre thus irritated. This fact, thus proved in *experiment* by M. Claude Bernard, the records of American medicine will show, was recognized and announced from *observation* in June, 1850.[2] In M. Bernard's *experimental* investigation, the irritation was applied directly to the nervous centre; in the induction from *observation*, *peripheral* irritation through the dental branches of the fifth nerve was recognized as competent to excite the secretion, and modify the products of secretion. The *observation* here, and not the more recent *experiment*, was the real parent of the principle of *excito-secretion*. The conclusion arrived at, from the observation of pathological phenomena, em-

[1] Op. citat., p. 288.

[2] Southern Medical and Surgical Journal, vol. vi. p. 321.

braced all the *elements* of the excito-secretory function, viz: first, a sensitive nerve as an excitor; secondly, a cerebro-spinal centre; thirdly, the secretory nerves and ganglia. M. Bernard's experimental results were *deficient* in the first of these elements, viz., the sensitive nerve as an excitor.[1]

To illustrate the connection of these various parts with the two divisions of the nervous system, we have introduced another figure from page 322 of M. Bernard's excellent work:—

In transferring to our pages the next figure, we have omitted the explanations, but would here remind the reader that analogous relations subsist between the secretory filaments of the alimentary canal, not represented here, and the cerebro spinal centres and cerebro-spinal sensitive branches.

We will make special reference to only one more set of pathological phenomena, as peculiarly illustrative of the excito-secretory function of the nervous system; we refer to some of those very mysterious aberrations of secretion found so uniformly concomitant with attacks of *hysteria.* Almost universal opinion has referred the manifesations of this disease to irritation of one kind or another, in the generative organs of females, viz., the ovaria, neck of the womb, and the uterus itself. It is a significant fact, that females laboring under this disease should so frequently manifest modification in their *urinary* secretion. "It appears, indeed," says Laycock, "that some alteration in the quantity or composition of the urinary secretion is one of the most constant symptoms of hysteria, even in its mildest form, when the patient can only be said to have a hysterical constitution."[2] "Limpid urine," in large quantities, is nearly always a concomitant, and Dr. Laycock also refers to "the profuse sweats and *salivation* of hysterical females." We regard all these secretory phenomena as fully explicable, by referring them in many instances to the excito-secretory function.

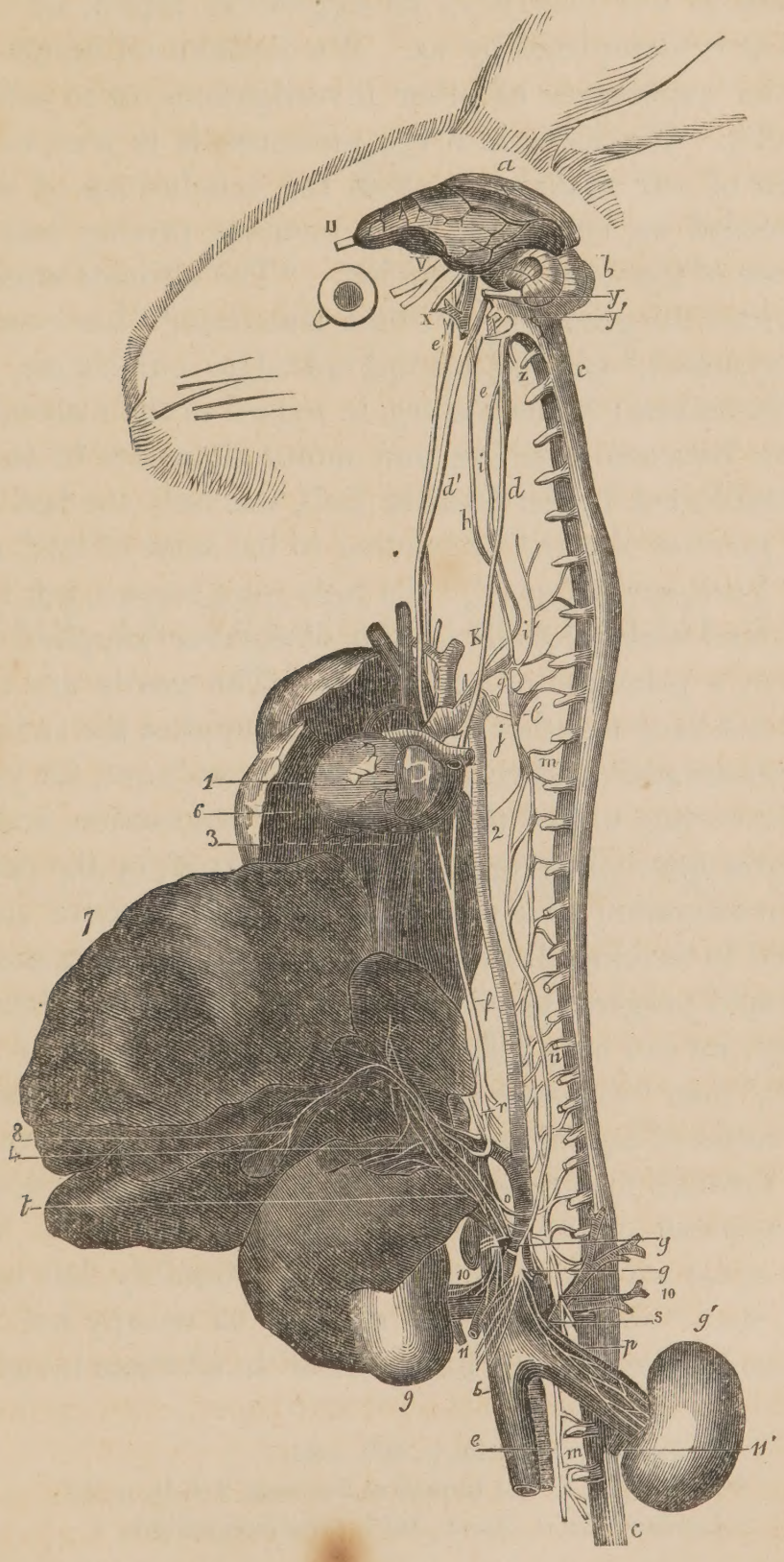
The records of both physiological and pathological medicine, would furnish a still more abundant treasure of facts, which could be made to corroborate our views in reference to this function of the nervous system, but such an extended discussion would not be consonant with the object of the present paper. Our earnest endea-

[1] We have not tested in any instance the chemical properties of the urine of teething children, but we would here respectfully suggest that it will be found to contain *sugar* in those cases in which the increased urinary secretion presents a prominent feature in the concomitants of dentition.

[2] Op. citat., p. 86.

vor has been to bring together from all sources, however diverse and unpromising, a sufficient number of kindred facts to establish,

Fig. 6



Cerebro-spinal and Splanchnic Nervous Systems of a Rabbit, showing the nervous connections existing between the liver, lung, and kidney, to explain the production of artificial diabetes.

more fully, perhaps, than has heretofore been done, the physiological and pathological relations of the excito-secretory system of nerves. This dissociation of old facts from their accustomed and apparently *established* relations, and the transferring of them to new ones, may have given to our discussion an aggressive aspect, by no means intended or contemplated by us. We disclaim all intention to underrate the importance of other investigations, or to misinterpret their results. We have, in a few instances, it is true, endeavored to the best of our ability to correct the conclusions of some who have preceded us, but never, for a moment, prizing less the real significance of the data in discussion. "The ultimate attainment of truth," writes the great Sir William Hamilton,[1] "has ever been by *gradual approach*," and, as not unkindred to our theme, we quote his apt illustration: "The history, in regard to the discovery of the distinction between sensitive and motor filaments in the nerves, finally established by Sir Charles Bell, was only the last of a long series of *previous observations* tending to the same effect;" or, in the words of Professor Whewell, "the facts were known, but they were insulated and unconnected till the discoverer supplied, from his own stores, a principle of connection. The pearls are there, but they will not hang together till some one supplies the string."[2] By diligent observation and careful induction, we have, for years past, been endeavoring to find this principle of connection, and to place these pearls upon their appropriate string; if, in the earnest and honest investigation of a somewhat new and obscure subject, we have failed to develop all that the advantages, previous suggestions, and the rapid progress of science must unfold in this extensive field of inquiry, we can only refer to the recent expression of Dr. Marshall Hall,[3] that "this vast subject demands a most extensive and cautious series of *experiments* and *observations*. The efforts of many laborers, through many years, will be required fully to develop the two sub-systems of the Diastaltic Nervous System." We must cordially agree with him, but would here humbly, but most earnestly ask, that "observation" be allowed to occupy her true and equal place by the side of "experiment" in all these investigations.

[1] Philosophical Works, p. 400, note.

[2] Philosophy of the Inductive Sciences, vol. ii. p. 48.

[3] London Lancet, March, 1857, American edition.

IV.

A CLAIM

OF

PRIORITY IN THE DISCOVERY AND NAMING

OF THE

EXCITO-SECRETORY SYSTEM OF NERVES.

[FOR THE LONDON LANCET.]

LETTER.

AUGUSTA, GEORGIA, U. S., March 2, 1857.

TO MARSHALL HALL, M. D., of London, F. R. S., &c.

MY DEAR SIR—In the number of the *London Lancet* republished in this country, for March, 1857 (present month), I have just read a paper from your distinguished pen; and in this paper you *announce* a system of EXCITO-SECRETORY *Nerves*, in the following connection and in the following terms:—

"In a memoir read at the Royal Society in February, 1837, I announced the existence of an EXCITO-MOTORY system of Nerves.

"I believe I may now announce a system or sub-system of EXCITO-SECRETORY Nerves, not less extensive."

As the above announcement is here made in close relation with a discovery long admitted to be your own, viz., that of the Excito-*motory* system of nerves, and inasmuch as in your subsequent remarks you attribute the proposition to no one else, I am left to infer that it is deemed by you an original deduction from the admitted facts of Anatomical and Physiological Science, as developed by observations and experiments during the last and the present century. Some of these last—viz., the experiments of Mons. Claude Bernard, of Paris—you adduce with the apparent intention of fortifying the views you here express.

Finding in none of your communications upon this interesting topic, any mention made of my name or of my records, I am, with regret, impelled, from considerations of courtesy to you and of justice to myself, to call your attention to the registration of my own labors in the same important field. I will, however, first direct you particularly, though briefly, to several portions of your own communication, in order that they may be placed in convenient juxtaposition with my own records, without giving the trouble of each time referring to the pages of the *Lancet:*

"But the most remarkable proof of *the doctrine which I am endeavoring to unfold* is furnished by the brilliant discovery and skilful experiments of M. Cl. Bernard"—

And you here refer to his well known experiments on the pneumogastric nerve in its relation to the secretions of the liver, published in his Lectures on Experimental Physiology, during the winter session of 1854 and 1855.[1]

In the earlier part of your communication (March, 1857), you thus announce the addition of this, as you suppose, *new* sub-system, to what you term the "Diastaltic Nervous System," the term "henceforth" apparently being used to date the initial moment of an era:—

"*Henceforth* the Diastaltic Nervous System must be divided into TWO sub-systems:—

I. The Excito-motory.
II. The Excito-secretory.

"The former is extended to the entire muscular system; the latter is diffused over the general system as the blood is diffused over the system."

Again, in reference to the *Pathological* Relations of the *Excito-secretory* System, you remark:—

"The *Pathology* of the Excito-secretory sub-system remains to be investigated and traced. A partial keen current of air falling on *any* portion of the skin may induce inflammation in *any* susceptible internal organ. An extensive burn or scald is apt to produce pneumonia."

And as my last quotation for the present:—

"But here I close this brief communication. My present object is only *to draw the merest sketch* of this *vast subject* which demands a most extensive and cautious series of experiments and observations. The efforts of many laborers, through many years, will be required fully to develop the *two* sub-systems of the diastaltic nervous system.

"I propose shortly to treat this important subject at greater length and with more details."

Now, my dear sir, by a reference to the following series of records, running through a period of nearly seven years, you will at once perceive that the EXCITO-SECRETORY function of the nery-

[1] Leçons de Physiologie, p. 325. Paris, 1855.

ous system has been the subject of earnest and diligent inquiry, and also of *plain record*, with me, for a length of time far anterior to that at which either yourself or Mons. Bernard had published anything on the subject.

You will herein also perceive, that this system of nerves has been plainly recognized and set forth as considered *in its relations to Pathology*, through which, indeed, its *Physiology* has been mainly deduced by me. And, lastly, that this system of nerves, before plainly stated and amply discussed, was, as early as May 5, 1853, in the presence of the American Medical Association, the highest tribunal in the medical sciences within my reach, *publicly* NAMED *by me* the EXCITO-SECRETORY: and that too in juxtaposition with and contradistinction to, your own discovery, viz., the EXCITO-MOTORY function.

This name or verbal combination, then, for the very first time, printed in the English language, or, indeed, in *any other* language, had not, so far as I can learn, after continued and interested inquiry on my part, been printed a second time, until taken from your own recent manuscript, it appears at the heading of your paper in the March number of the *London Lancet* (American edition), and thus becomes the occasion of the present communication.

Below, I now present you with certain passages from an article on "The Influence of Dentition in producing Disease," read before the Medical Society of Augusta, Georgia, in May, 1850, and afterwards published in this city, in the *Southern Medical and Surgical Journal*, a periodical circulating extensively and exchanging with all the medical journals in this country and with many of those of Europe. Here you will *now* find these several records presented to you seriatim and in that order, together with the dates and accompanying circumstances, in which they were *long ago* successively presented to the profession.

May 2, 1850. "Dr. HENRY F. CAMPBELL read an Essay on the Influence of Dentition in producing Disease."—[*From Minutes of a meeting of the Medical Society of Augusta, Georgia.*]

I will not quote from, or remark upon the essay now, but fully hereafter as published below.

June, 1850. Permit me, now, respected sir, to refer you to the pages of the *Southern Medical and Surgical Journal*, new series, vol. vi. No. 6, June, 1850. (Part I.—Original Communications: Article XV., p. 321). You will, in this place, find the paper just cited, published—viz: "An Essay on the Influence of Dentition in pro-

ducing Disease. By Henry F. Campbell, M.D., Demonstrator of Anatomy in the Medical College of Georgia."

Here you will find that I have, in the beginning, sketched prominently the two orders of phenomena which occur during the period of dentition, viz., the *convulsive* and the *secretory*, explaining the first easily enough, by a reference to the principles of excito-*motory* action laid down by yourself; while the other set of phenomena I presented in such a manner as that, from them, the excito-*secretory* function of the nervous system became an *obvious* and an *unavoidable deduction*—by this means mutually establishing a physiological principle before scarcely ever broached or hinted at; and in the second place, leaving no chance to escape the necessary admission that this set of phenomena, before perfectly inexplicable to the profession, could only be rationally interpreted by the admission of that very physiological principle. In doing this, "the two subsystems," as you now term them, were, throughout, kept in *close relation*, but in *decided contrast*, the one being used, occasionally it is true, to illustrate the other, but never for a moment becoming *confounded* with the other. Thus: "*Now let us inquire how far these phenomena are dependent upon Dentition; and* ANALOGY with the EXCITO-MOTORY system will much assist us in our argument. We have seen that local irritation can, through this system, produce convulsions by the reflex function of the nerves, the sensitive branches of the fifth pair becoming excitor to the *motory spinal* nerves; and so, may we justly infer, do these same branches, under certain circumstances, become *excitor* to the SECRETORY filaments of the *sympathetic*, distributed so abundantly to the intestinal canal by a transmission of this irritation through the various ganglia with which it is connected."

You will also here see that the discussion is carried still further into the pathological relations of the then new function, and that I have instanced nearly all those localities which you have recently adduced, and that I have considered those changes in the blood while eliminating the secretions under nervous influence, which you in your paper designate by the word *methœmatous;* as in the following: "Thus the irritation at first produces simply an *exaltation* of the innervation of the secretory surfaces, and secretion is more *active* than normal, producing *simple diarrhœa.* A continuance of the irritation *alters* the *character of the secretion*, and we have the various morbid discharges observable during this period. This *increase* and *change* in the secretion are effected by the agency of the

altered function of the nerve upon the arteries from which these secretions are eliminated."—(See *Southern Medical and Surgical Journal*, p. 331.)

Without further remark, at present, I will lay before you that portion of this essay which embodies my first record upon the excito-secretory function of the nervous system.

"The period of dentition has ever been regarded one of peculiar interest, as well to the pathologist as to the practitioner. That certain diseases are more apt to occur during this season, few pretend to deny; but the amount of the symptoms, due to the irritation of teething, has been variously estimated, some attributing to this cause nearly all the ills to which infancy is liable, while others ridicule the idea, that a process in itself so purely physiological and natural should be regarded *ever* a cause of disease.

"The object of our essay is to investigate impartially this important subject with the view of determining, as nearly as possible, to what extent the organism is affected by the evolution of the teeth. In doing so, it appears to us most rational, as a primary step in the investigation, to review briefly the phenomena of both normal and anormal dentition, with the view of finding the foundation of the pathogenic theory, if such exists, in the *physiology* of this process.

"The phenomena observed during easy or normal dentition may be briefly summed up as follows: The salivary secretion is increased, the gums are swollen, the mouth hot, and the child evinces a disposition to press every substance within its reach upon the gums, in order to relieve the irritation it here suffers. Later, the gums become more swollen and softer, the irritation more distressing, and, under certain circumstances, the mouth dry and slightly inflamed. The child becomes fretful; its sleep is disturbed and feverish, its bowels become loose, which latter symptom we frequently observe accompanied by nausea and vomiting. There is also described by some authors an irritation of the Schneiderian membrane, *with increased secretion*, marked by the child rubbing its nose.

"Cases of anormal dentition are brought more frequently under the cognizance of physicians, and their phenomena are hence familiar to every one. The above symptoms become exaggerated—some, which in normal dentition were of trivial importance, becoming so severe as to threaten the life of the patient. Thus, the gently relaxed condition of the bowels, which in easy dentition was even beneficial, is now changed to diarrhœa with distressing tormina and alarming emaciation. The salivary glands, which in easy

dentition manifested their implication only by *increased secretion*, now become inflamed and swollen, till finally their secretion is altogether arrested, leaving the mouth and tongue dry, parched, and painful; and the nervous fretfulness of the normal process is often replaced by actual fever, sometimes attended by the most terrific convulsions.

"We have here sketched hastily some of the more prominent phenomena of both easy and severe dentition, as we each daily observe in practice, and find reported by authors, and we do not adduce them at present, as the direct results or consequences of the process, but only as its pretty constant concomitants. In referring to those symptoms hereafter in the course of our essay, we will necessarily enlarge upon and develop more fully some of their characteristics. Let us now, with a little attention, enter into an analysis of these concomitants of dentition, and endeavor to ascertain whether or not their origin may be found in the process itself. To this end, we will consider briefly the *anatomy and physiology* of the parts concerned in this important and often perilous process of evolution."

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"From the above considerations we are induced to conclude that the *convulsions* are often produced by the irritation of dentition, and can be directly referred to this as the sole cause.

"We arrive now at a point in this somewhat obscure and much disputed question which, perhaps, affords more ground for doubt than any of the foregoing; viz., a consideration of the *pathogenic influence of dentition in the cholera infantum or diarrhœa* so uniformly co-existent with this process. Unlike the convulsions, the analogy between which and certain known and established phenomena of the excito-motory system, which it is only necessary to refer to, and their operation is plain and intelligible, this new set of symptoms, if we refer them to the process of dentition, requires us to look yet deeper into the mysteries of our nervous organization, and to *venture still one step further* on the *terra incerta* of sympathetic interpretation.

"In order to apply our arguments, let us hastily review the foregoing investigation, that they may bear more fully upon this part of our question; and, first, we have seen that inflammation, pain, and irritation are produced *locally* by the process of dentition, evinced by restlessness, biting, &c. Secondly, we have seen that this local irritation can be transmitted by excito-motory influence

to other and distant parts of the body, manifested by convulsions. We have also endeavored to corroborate this latter opinion by a reference to the order of succession in the nerves in which this irritation occurs, and also by a comparison of these phenomena with other well understood and established analogous phenomena. Heretofore we have had to deal entirely with functions of the cerebro-spinal system of nerves; but to account for this second and more obscure part of our problem, we must look in vain to any direct anatomical connection between the fifth pair and the rest of *this* system of nerves. *We are forced to seek out other connections, indeed somewhat more intricate and indirect, but fortunately no less legitimate and definable.* We have now to consider a set of organs which, unlike the voluntary muscles, have no connection, or rather we would say, emphatically, they *have* a connection, though indirectly, with the cerebro-spinal system. We mean the abdominal viscera, which we know are almost altogether supplied from the great sympathetic system of nerves. *Now, in the prosecution of our inquiry, it becomes necessary to the elucidation of the question to trace out the same connection between the fifth pair and the sympathetic or secretory, as we did between the fifth pair and the cerebro-spinal or motory nerves,* and then, should we succeed, we will briefly inquire into the bearing which this connection and its possible results may have upon our question.

"The connections between the fifth pair, the rest of the cerebro-spinal system of nerves and the great sympathetic, are so abundant and universal that it is only necessary to enumerate a few of them to illustrate the fact. First, we have a connection in the ophthalmic or first division, by its nasal branch communicating with the ciliary ganglion; then in the superior maxillary, or second division, are branches of communication with Meckel's ganglion; again, in the submaxillary ganglion, with the inferior maxillary or third division. So much for the fifth itself. Then we know that every one of the spinal nerves throughout the entire cord are connected to each sympathetic ganglion of the system, thus establishing communications the most abundant and intimate between these two systems of nerves. We know also that these ganglia distribute numerous branches to all the splanchnic viscera by plexuses which accompany the arterial trunks into the minute structure of these organs.

"Thus connected and distributed, this nerve presides over the important functions of nutrition and secretion, which office so characterizes it as to give it the name of the SECRETORY system. In

the physiology of the nervous system, there is no fact better established by anatomy and pathology, as well as by experiments on the lower animals, than this, that the sympathetic nerve, whatever else may be its functions, always forms a necessary element in the nutrient and secretory apparatus of all the splanchnic viscera; and further, that upon its sanity depends the due administration of these two great functions. It is the nerve for the bloodvessels; 'and,' remark Todd and Bowman, 'as secretion is mainly dependent on the normal nutrition of glands, it is reasonable to suppose that that function would be to a certain extent controlled by these nerves.' And as early as the year 1732, Pourfour du Petit found that the division of the trunk of the sympathetic, opposite the fourth or fifth cervical vertebra in dogs, was followed very rapidly by great disturbance of the circulation of the eyeball, producing inflammation, flattening of the cornea, and finally destruction of this organ.

"The experiments of Dupuy upon the horse, wherein he severed this nerve at the superior cervical ganglion, also corroborate this statement; general emaciation here ensued, with an anasarcous condition of the limbs and an eruption over the whole cutaneous surface.

"In some experiments made by Dr. J. Reid, and reported by Todd and Bowman, in reference to the sympathetic branches supplying the eye, it was found that the effect of a section of this nerve was to produce an immediate injection of the conjunctiva. In one case, he observes, the redness of the conjunctiva took place in a few minutes after the section. It has been already stated, continue these great authors, that a section of the branches of the fifth nerve which supply the eye is followed by ulceration and other signs of impaired nutrition in the eyeball. But these changes do not take place for some time after the section of the nerve—generally many days elapse—and they are attributable to the presence of irritating particles which, owing to the insensible state of the conjunctiva, are suffered to remain in contact with the surface of the eye, giving rise to inflammation and ulceration of its textures. The effects of section of the sympathetic are *immediate*, and are probably due to a change produced in the bloodvessels in consequence of the withdrawal of the accustomed nervous influence.

"We have now glanced sufficiently, we think, at the anatomy and physiology of the sympathetic system of nerves, to make the application of such points as are pertinent in the solution of our pathological problem. In its anatomy, we have seen its connections with

all three of the divisions of the fifth nerve by ganglia, the connection of these various ganglia with each other, as well as with the cerebro-spinal axis; and lastly, the distribution of branches from these ganglia, which are conducted by the arteries into every part of every one of the splanchnic viscera. In its physiology, we find it in entire charge of the important functions of nutrition and secretion, and that wherever these processes are effected it is by the agency of this nerve alone upon the bloodvessels. And further, we have seen that pathology and experiments on lower animals establish its indispensableness to the due performance of these functions, and that whenever the supply of its innervation has been cut off from a particular part of the organism, that part immediately manifests symptoms of *impaired nutrition* and *altered secretion.*

"Now we are all aware that nearly the whole of the intestinal canal, or rather that portion between the stomach and lower part of the colon, receives no direct innervation from the cerebro-spinal axis, but is entirely dependent upon the sympathetic nerve for its supply of nervous influence of whatever kind it may enjoy, whether motory, sensory, or secretory, and consequently an impairment of the function of this nerve must necessarily correspondently alter its condition so far as regards all those functions with which this nerve endows it. The alteration in these functions would of course depend in a great degree upon the amount of impairment in the source of irritation; thus, as we have seen, if the supply is entirely cut off, the functions of the arteries seem in a great measure to cease, passive congestions occur, and the parts inflame and ulcerate. Now we can also very naturally conceive of a condition of these nerves somewhat analogous to the above, yet intermediate between the entire interruption caused by section, and perfect health—a condition of embarrassed or of exalted innervation. Now this intermediate condition is exactly the state which, from the developments of the foregoing investigation, we feel that we are authorized to affirm is that which occurs in severe dentition, and that upon it is dependent the whole train of intestinal morbid phenomena observable during this process.

"That this, so far, is legitimately inferable, we do not think any one will deny. Now let us inquire how far these phenomena are dependent upon dentition; and *analogy* with the *excito-motory* system will much assist us in our argument. We have seen that local irritations can, through this system, produce convulsions by the reflex function of the nerves, the *sensitive branches* of the fifth pair becom-

ing *excitor* to the *motory* spinal nerves; and so may we justly infer do these *same branches*, under certain circumstances, become excitor to the *secretory* filaments of the *sympathetic*, distributed so abundantly to the intestinal canal, by transmission of this irritation through the various ganglia with which it is connected. Thus the irritation at first produces simply an exaltation of the innervation of these secretory surfaces, and consequently secretion is more active than normal, producing simple *diarrhœa*. A continuance of the irritation alters the *character* of the secretion, and we have the various morbid discharges observable during this period. This increase and *change in the secretion are effected by the agency of the altered function of the nerve upon the arteries from which these secretions are eliminated.* Now when the innervation of these arteries is still further embarrassed by the long continuance of the *reflected irritation*, the state of things nearly approaches that observed in Dupuy's, Reid's, and Pourfour du Petit's experiments of actual destruction of the nerve, and we have ulceration of the intestinal mucous membrane; all these phenomena being the result of various degrees of injury sustained by the sympathetic nerve.

"It may here be asked, why should the branches supplying the intestinal mucous membrane become more implicated than any other portion of the sympathetic system?—and why do not similar irritations of the fifth nerve produce like results in the adult? To the first of these questions we answer that most probably the other portions *are* implicated, but the manifestations of such implication are greater and graver here than elsewhere, because these are the sole sources of innervation to the viscus. The other organs are in all probability implicated, but receiving a certain amount of innervation from other sources, most of their functions not being entirely secretory, are still, though imperfectly, carried on. But in the intestinal canal the case is far different; the requisitions made upon it are of a nature that it has need for no other innervation than that of the sympathetic system. *Its functions are secretion and nutrition for the whole animal organism;* and when these are impaired, its primary—indeed, its *only*—intents are altered or completely nullified. The second question is answered by the greater development of this system in the growing than in the adult individual, for the purpose of supplying the more active nutrition and secretion at that time necessary. We know that disease is more apt to occur in many parts of the body during this period;—this is the general admission. Thus, according to many authors, among

whom are West, Churchill, &c., pneumonia and bronchitis are more apt to attack children during dentition than at any previous or subsequent period. Cutaneous eruptions, and many other aberrations of secretion occurring during this period, but serve to corroborate our theory of the origin of the morbid intestinal secretion. The increased vermicular action and tormina attending this affection find a ready explanation in the fact, now well established, that the sympathetic receives both motor and sensitive filaments from the anterior and posterior roots of the spinal nerves, endowing the organs of their distribution, to a certain degree, with corresponding susceptibilities.

"In conclusion, let us define the position which, at the end of our investigation, we feel warranted in assuming. It is the following: that in the anatomy and physiology, as well as in the dependent analogies of the process of dentition, we find ample ground for the opinion that the diseases pertaining to this period *may be dependent, and in many cases are entirely so, upon the local irritation attending the process being transmitted through either the cerebro-spinal system of nerves, producing convulsive diseases in the motory apparatus, or through the sympathetic, causing derangements in the secretory organs, particularly the alimentary canal, by the sway which it exercises over the arterial system, from which these secretions are eliminated.* And the practical deductions to be drawn from these conclusions are, that we should not be remiss in taking every measure to arrest or lessen this local irritation, either by free and repeated incisions of the gums, or by the judicious administration of appropriate remedies, among which we have found opiates to prove most safe and efficient.

"It would, indeed, be an improving, and not an unpleasing, exercise to trace out more fully the connections between the local irritation and the various diseases occurring during the period of dentition, to take more extended views of the abundant analogies and comparisons afforded by this truly prolific subject; but time and the special object of our essay do not warrant the indulgence in speculations so general and discursive.

"Our object has been to trace the connection between this process and diseases in general only in so far as it has a bearing upon the establishment of one principal question in reference to the diarrhœa of this period. The subject has been only glanced at, and deserves a fuller and more extended treatise, wherein all the concomitant diseases of dentition, as *dropsy*, *eruptions*, and the many infantile

neuroses, should be fully and carefully discussed. Such views we would earnestly invite from some abler and more philosophic member of the profession."

The circumstances of my second published record are the following: At the fifth annual meeting of the American Medical Association (1852), held in Richmond, Va., not being present myself, I was appointed a special committee to prepare an essay on the subject of Typhoid Fever, which essay was read before that body in New York, in May, 1853. In this paper I took occasion to consider carefully the ganglionic system, in support of the position therein assumed, *that all typhoid fevers were manifestations of disease through the secretory system of nerves.* While thus engaged, my attention was called to certain experiments performed by Mons. Claude Bernard, of Paris, and made public through the *Gazette Médicale*, and translated in the *New Orleans Medical Register*, together with his deductions therefrom.

On examination, finding that they contained what at that time appeared to me the germ of a theory similar to mine, recorded in June, 1850, though he refers to them as "a set of phenomena *identical* with those occurring in the cerebro-spinal system of nerves, denominated excito-motory by Dr. Marshall Hall," while I had deduced this *excito-secretory* system (in 1850), saying, "*analogy* with the *excito-motory* system will much assist us in our argument;" and further, inasmuch as this distinguished gentleman's report presented itself to my mind at that time somewhat in the form of an announcement, I deemed it advisable to appeal to our National Medical Congress in the following brief memoir, *praying permission to record before them* MY CLAIM TO PRIORITY, and also my protest against the palm of originality attaching to Mons. Claude Bernard.

[ABSTRACT FROM THE TRANSACTIONS OF THE AMERICAN MEDICAL ASSOCIATION. MEETING HELD IN THE CITY OF NEW YORK, MAY 3, 1853.]

"Dr. Campbell, of Georgia, submitted a paper on a question of priority in reference to the discovery of the reflex relation subsisting between the cerebro-spinal and sympathetic system of nerves." —See *Minutes of Sixth Annual Meeting*, vol. vi. p. 49.

"*On the Sympathetic Nerve in Reflex Phenomena.* By HENRY F. CAMPBELL, of Georgia.

"In a recent number of the *Gazette Médicale* appear some remarks,[1] by M. Cle. Bernard, on the Reflex Actions of the Nervous System. In these he refers one order of such reflex phenomena to the sympathetic system of nerves, and illustrates, by experiments upon the frog, as well as by reference to many of the acts of nutrition and secretion, that such a relation exists between the cerebro-spinal and ganglionic system of nerves, as well as between the excitor and motory portions of the cerebro-spinal system. Or, in his own words, 'two kinds of nerves are requisite for the production of these reflex phenomena of organic life: the first transmits the impression to the nervous centres; the second, to the viscera. With one order of these nervous filaments is always connected a ganglion of the great sympathetic. Example: the lingual nerve transmits the impression of the taste to the nervous centres; a special nerve then conveys a corresponding excitation to the submaxillary gland; on one of these nerves is situated a ganglion of the sympathetic, the submaxillary ganglion,' &c. He gives several illustrations of this fact, and further, appears to be of the opinion that this set of phenomena are *identical* with those occurring in the cerebro-spinal system of nerves denominated *excito-motory* by Dr. Marshall Hall; but with this latter part of his paper we have nothing to do. It is only with that portion in which he appears to claim as his own, the suggestion of the theory that there does exist such a reflex relation between the sympathetic and the cerebro-spinal systems, and his presentation of it as an observation entirely new.

"Now we are not aware of the exact length of time that these views have been held by physiologists; they may be old, or, on the other hand, they may be of recent suggestion; but certainly we cannot award to M. Bernard the merit of being the first to express such views in relation to the function of the sympathetic system of nerves; and while we are exceedingly reluctant to refer to our own humble labors in connection with the brilliant discoveries of this most philosophic and able observer, a sense of duty to ourself, as a member of this National Association, prompts us not to allow this assertion to pass unchallenged.

[1] Translated by the New Orleans Medical Register.

"A reference to a paper presented by us to the Medical Society of Augusta, Georgia, and published in the *Southern Medical and Surgical Journal*, on the Influence of Dentition in producing Disease, will show that this subject was fully discussed by us as early as June, 1850, and that the whole argument upon which our theory of the mode in which dentition does produce certain morbid results (diarrhœa, for instance) is based upon the supposed existence of such a reflex relation between the cerebro-spinal and ganglionic systems of nerves, as will be seen by the following: After referring the occurrence of *convulsions*, during dentition, to the reflex relations existing between certain nerves of the cerebro-spinal system, viz., the fifth pair as excitor, and the muscular branches of the spinal system as motory, we then endeavor to account for the occurrence of *diarrhœa* by establishing the existence of a similar relation between the cerebro-spinal and branches of the ganglionic system supplying the intestinal canal; which suggestions will be found embodied in the following extract from our essay in the June number of the *Southern Medical and Surgical Journal*, for 1850, p. 329: 'We have now glanced sufficiently, we think, at the anatomy and physiology of the sympathetic system of nerves to make the application of such points as are pertinent in the solution of our pathological problem. In its anatomy, we have seen its connections with all three of the divisions of the fifth nerve by ganglia, the connection of these various ganglia with each other, as well as with the cerebro-spinal axis, and lastly, the distribution of branches from these ganglia, which are conducted by the arteries into every part of every one of the splanchnic viscera. In its physiology, we find it in entire charge of the important functions of nutrition and secretion, and that, wherever these processes are effected, it is by the agency of this nerve alone upon the bloodvessels. And further, we have seen that pathology and experiments upon the lower animals establish its indispensableness to the due performance of these functions, and that, whenever the supply of its innervation has been cut off from any particular part of the organism, that part immediately manifests symptoms of impaired nutrition and altered secretion.

"'Now, we are all aware that nearly the whole of the intestinal canal, or rather that portion between the stomach and lower part of the colon, receives no direct innervation from the cerebro-spinal axis, but is entirely dependent upon the sympathetic nerve for its supply of nervous influence, of whatever kind it may enjoy, whether

motory, sensory, or secretory, and consequently an impairment in the function of this nerve must, necessarily, correspondently alter its condition, so far as regards all those functions with which this nerve endows it. The alteration in these functions would, of course, depend, in a great degree, upon the amount of impairment in the source of irritation; thus, as we have seen, if the supply be entirely cut off, the functions of the arteries seem, in a great measure, to cease, passive congestions occur, and the parts inflame and ulcerate. Now, we can also very naturally conceive of a condition of these nerves somewhat analogous to the above, yet intermediate between the entire interruption caused by section and perfect health—a condition of embarrassed, or, perhaps, of exalted innervation. Now, this intermediate condition is exactly the state which, from the developments of the foregoing investigation, we feel that we are authorized to affirm, is that which occurs as the result of severe dentition, and that upon it is dependent the whole train of intestinal morbid phenomena observable during this process.

"'That this so far is legitimately inferable, we do not think any one will deny. Now let us inquire how far these phenomena are dependent upon dentition; *and analogy with the excito-motory* system will much assist us in our argument. We have seen that local irritations can, through this system, produce convulsions by the reflex function of the nerves, the sensitive branches of the fifth pair becoming *excitor* to the *motory* spinal nerves; *and so, we may justly infer, do these same branches (of the fifth pair), under certain circumstances, become excitor to the secretory filaments of the sympathetic, distributed so abundantly to the intestinal canal* by a transmission of this irritation through the various ganglia with which it is connected. *Thus, the irritation at first produces simply an exaltation of the innervation of these secretory surfaces, and consequently secretion is more active than normal, producing simple diarrhœa. A continuance of the irritation alters the character of the secretion, and we have the various morbid discharges observable during this period. This increase and change in the secretion are effected by the agency of the altered function of the* nerve upon the arteries from which these secretions are eliminated. Now, when the innervation of these arteries is still further embarrassed by the long continuance of the *reflected irritation*, the state of things nearly approaches what was observed in Dupuy's, Reid's, and Pourfour du Petit's experiments, of actual destruction of the nerve, and we have ulceration of the

intestinal mucous membrane; all these phenomena being the result of various degrees of injury sustained by the sympathetic nerve. It may here be asked—why should the branches supplying the intestinal mucous membrane become more implicated than any other portion of the sympathetic system? And why do not similar irritations of the *fifth nerve* produce like results in the adult? To the first of these questions we answer, that most probably the other portions *are* implicated; but the manifestations of such implication are greater and graver here than elsewhere, because these sympathetic branches are the sole sources of innervation to the viscus. Other organs are in all probability affected; but, receiving a certain amount of innervation from other sources, most of their functions, not being entirely secretory, are still, though imperfectly, carried on. But in the intestinal canal the case is far different; the requisitions made upon it are of such a nature that it has need for no other innervation than that of the sympathetic system. Its functions are secretion and nutrition for the whole animal organism, and when these are impaired, its primary, indeed, its only intents are altered, or completely nullified. The second question is answered by the greater development of this system in the growing than in the adult individual, for the purpose of supplying the more active nutrition and secretion at that time necessary. We know that disease is more apt to occur in many parts of the body during this period than at other times; this is the general admission. Thus, according to many authors, among whom are West, Churchill, &c., pneumonia and bronchitis are more apt to attack children during dentition than at any previous or subsequent period. Cutaneous eruptions, and many other aberrations of secretion occurring during this period, serve to corroborate our theory of the origin of the morbid intestinal secretion. The increased vermicular action and tormina attending this affection find a ready explanation in the fact, now well established, that the sympathetic receives both motor and sensitive filaments from the anterior and posterior roots of the spinal nerves, endowing the organs of their distribution, to a certain degree, with corresponding susceptibilities.

"'*In conclusion, let us define the position which, at the end of our investigation, we feel warranted in assuming. It is the following: That in the anatomy and physiology, as well as in the dependent analogies of the process of dentition, we find ample ground for the opinion that the diseases pertaining to this period may be dependent, and in many instances are entirely so,* UPON THE LOCAL IRRITATION ATTENDING THE

PROCESS, BEING TRANSMITTED THROUGH *the cerebro-spinal system of nerves, producing convulsive diseases in the motory apparatus*, OR THROUGH THE SYMPATHETIC, CAUSING DERANGEMENTS OF THE SECRETORY ORGANS, PARTICULARLY OF THE ALIMENTARY CANAL, *by the sway which it exercises over the arterial system from which these secretions are eliminated.*'

"In the above brief quotation, it will be observed that the doctrine of the reflex function between the cerebro-spinal and sympathetic systems is plainly enunciated, and not only is the physiological fact noted, but we there also have surmised the *transmission* of *permanent* irritation, or of paralysis from the cerebro-spinal to the sympathetic system, giving rise to various aberrations in nutrition and secretion. *This opinion we have held for several years, teaching to our classes that there* EXISTED BETWEEN THE CEREBRO-SPINAL *and the* GANGLIONIC *system of nerves a relation* SIMILAR *to that between the sensitive and motor branches of the cerebro spinal, and which Marshall Hall terms* EXCITO-MOTORY; WHILE WE HAVE TERMED THAT BETWEEN THE CEREBRO-SPINAL AND SYMPATHETIC *systems* EXCITO-SECRETORY.

"As we have before indicated in this report, we do not feel authorized to lay full claim to the above theory without further investigation of the subject; but with all due courtesy to that highly distinguished gentleman, we can say that we feel assured that these views are not original with M. Bernard, unless he entertained them previous to June, 1850. There may have been other similar observations; but until the publication of M. Bernard's, we had not noticed them elsewhere than in our paper on Dentition."

You will perceive that in the above memoir, I have introduced enough from the first record to constitute a pretty complete *résumé* of my original announcement and process of induction. But being apprehensive that the doctrine of a *new function* so clearly and publicly defined, would suggest its appropriate NAME to some one before I was prepared to take up the subject again, I, on this occasion, condensed into a short paragraph, as you will see near the end of the paper, a *comprehensive* RE-STATEMENT *of my doctrine*, and placing it in juxtaposition with your own distinguished name, and also in contradistinction to your own great *analogous* discovery of the *Excito*-MOTORY system, after *emphasizing* the word "similar" to indicate that I did *not* consider them "*identical*," I applied to it the expressive designation (now used by yourself) of EXCITO-SECRE-

TORY—*a word never before that moment* (*as I believe and have above stated*) *written by any other person in any language*, except by me, in my private notes.

As an evidence of the importance attached to this brief communication by the publishing committee of the Association, I call your attention to the fact that it is rendered conspicuous by not less than *four* references in the short index at the end of this volume of the *Transactions*. On the appearance of the volume (Vol. VI., 1853), several of the prominent scientific periodicals made special reference to my claim of priority preferred against Mons. Cle. Bernard, during their review of the *Transactions*. I send you two of these, the most prominent, perhaps, now at hand:—

From the *American Journal of the Medical Sciences*, January, 1854, No. LIII., new series, p. 135. Edited by Isaac Hays, M. D., Philadelphia, Pa.

"The next article is a short paper by Dr. HENRY F. CAMPBELL, of Georgia, in which that gentleman lays claim to priority in the enunciation of the doctrine that there exists a reflex relationship between the sympathetic and the cerebro-spinal system of nerves, which has been recently claimed by Dr. Bernard, of Paris, as an observation entirely new and original with him. Dr. Campbell has shown that, at least, priority of publication is with him."

The next is from the *New York Journal of Medicine*, new series, p. 254, vol. xii. No. 2, March, 1854. Edited by S. S. Purple, M.D., and Stephen Smith, M. D.

"*On the Sympathetic Nerve in Reflex Phenomena*, by HENRY F. CAMPBELL, M. D., of Geo.—The design of this short article is to establish the precedence of the writer's enunciation of the doctrine of a reflex relation existing between the cerebro-spinal and ganglionic system of nerves, recently put forth by M. Bernard. The views of Dr. Campbell are contained in a paper on the Influence of Dentition in producing Disease, published in the *Southern Medical and Surgical Journal*, in 1850. The author certainly establishes his claim to priority of publication, as far as regards Bernard's article referred to in the *Gazette Médicale;* but, if we are not mistaken, similar views have been advanced at a still earlier date. As he does not, however, pretend to priority over all others, but only so far as his information extends, we will not be to the trouble of examining the subject further."

You will here perceive that the above claim of *priority* over Mons. Claude Bernard, in 1854, is distinctly referred to, and recognized by two of the leading medical periodicals of this country, both of which have exchanges in Europe, and the first especially circulating and being read in your country, more, probably, than any other American Medical journal.

On the printing of the sixth volume of the *Transactions* of the American Medical Association, for 1853, I engaged with the publishers to strike off extra copies, for distribution, of the *Report on Typhoid Fever*, in which memoir the principle of the Reflex Phenomena between the cerebro-spinal and ganglionic or secretory system of nerves is recognized, though not made a prominent feature of the essay. The pamphlet made up from these extra sheets was sent to yourself, as well as to your distinguished contemporaries, Drs. W. B. Carpenter, R. B. Todd, Mr. W. Bowman, and Dr. W. Jenner; and more recently to Dr. T. B. Peacock, of St. Thomas's Hospital.

Near the close of last year, I was solicited to become senior editor of the *Southern Medical and Surgical Journal*, and, with this subject ever uppermost in my thoughts, you will observe that my first editorial work consisted in certain strictures upon a lecture on "The Effects of Dentition in Nursing Children," delivered at Hôtel Dieu, by Mons. Trousseau, of Paris, wherein I enter into a *restatement* of my views published in June, 1850, again bringing the *two great facts of the nervous system* into emphatic contradistinction and analogy, the *excito-motory* being indicated by the "convulsive phenomena," while the *excito-secretory* is instanced by the "diarrhœa" succeeding the local irritation in the sensitive branches of the fifth pair. From this I quote the following:—

"Here, it will be observed that we have unmistakable evidences of local irritation of the gums, which we know are supplied by branches of that most exquisitely sensitive of all sensitive nerves, the fifth pair; if we admit the principle of reflex action, we must recognize here a competent cause, considering the impressible character of the infant's nervous system, for the *convulsive* phenomena. On the other hand, we may trace a connection between the local irritation and the *diarrhœa* succeeding it, in an *analogous* manner, taking into view the intimate connections between the fifth pair and the nerves of the ganglionic nervous system, from which the intestinal mucous surfaces receive their *secretory* endowments.

"We have been thus careful (I here continue) in pointing out

the manner in which we think this *local iritation* may *produce* the convulsive symptoms, and also even *the increased secretion from the mucous surface of the bowels* and the *diarrhœa*, in order to give it what we consider its proper amount of importance, and to direct attention to this as the chief source of those difficulties calling for early and continued care."[1]

This is my latest printed record, published in this country, as you will perceive, *three months previously to your first;* but this important and extensive subject has never ceased to possess and stir my thoughts. Suggested to my mind in the first instance, by an accidental and trivial circumstance, occurring years ago, in the earliest days of my pupilage,[2] it became inwoven with the tissue of my thoughts, first, as an unpromising and tantalizing problem, it is true, but soon, as a broken seal—a revealed fact; and finally, as the familiar, *self-evident truth* of reflex nervous action.

And now, dear sir, I have completed the chain of evidence which I find in my published records upon this, to me, momentous subject. While it has been acknowledged on all hands that there is an *unity* in the truths of *nature*, it is a pleasing reflection that there is also an *universality* in the principles of *science*—nature's humble interpreter—which makes them the property of no one clime, or particular race of men, but parts of that vast and common treasury, for the benefit of all mankind. To this rapidly accumulating store, your own genius and unremitting energy have contributed more,

[1] Southern Medical and Surgical Journal, vol. xiii. pp. 20, 21.

[2] The "circumstance" here referred to is so illustrative of Excito-Secretory action, and withal so intimately connected with the origin and early history of the discovery, that we hope the reader will pardon us for venturing to introduce it here, notwithstanding its ludicrous import. It has indeed a laughable bearing, but it also had for us, in those early years of our reasoning, an import and a significance pregnant with the most serious and earnest reflections, for to them we owe all of whatever we have accomplished in this department of the nervous system.

The case is that of a *Teething Infant affected* with profuse and frequent *micturition*. The mother of the child, an illiterate woman, seemed fully impressed with the idea, that the frequent urination was dependent upon the fact that the child was teething; for she said to the attending physician: "Doctor, my child is teething and has '*the pees vehemently*' bad."—It was in the working out of this problem, viz., the etiological connection between these two facts, so ludicrously stated, that we first developed the theory of Excito-secretory action, and afterwards applied it to the enteric and cutaneous phenomena of Dentition. In the first edition of this letter to Dr. Marshall Hall, we made no particular statement of these earlier views, because, of course, we wished to rest our claim only upon the *printed* records.

much more, than often falls to the lot of one member of this great commonwealth to gather. Your name must ever be associated with the history of doctrines in the physiology of the nervous system, acknowledged and made the basis of induction in every portion of the scientific world. Observing you, admiring you, and studying you closely, can you censure me if I have wished, in some degree, to *emulate* you, and place my humble name, one day, near your own on the scroll of science. That day is now, I hope, about to arrive; you have intimated that this *excito-secretory* function of the nervous system, which, as I think, I have herein shown has been developed and named by me in 1850 and 1853, is a principle not less extensive than the *excito-motory* function developed and named by you in 1837. You have said, most truly, that it is "a vast subject, requiring many laborers and many years fully to develop that and the other sub-system." I here ask permission to express the wish, that as long and as usefully as you have already lived, you may still be spared to add much to the *fuller* development of the *excito-secretory* system, much more than I could ever hope alone to accomplish.

Mingled with other feelings, all of which are at this moment those of sincere kindness, is the regret that my repeated publications on this subject have never reached your eye. I feel that I am not chargeable with having omitted to give publicity to my records, as the annals of the American Medical Association will plainly reveal. As you intend publishing shortly more in detail upon these subjects, I here earnestly and respectfully ask the honor of having my records meet due acknowledgment at your distinguished hands.

And now, respected sir, I will close this already too prolonged communication: as courtesy to you, and justice to myself, were professedly the instigating causes of its inditement, I do most sincerely hope, that in the too earnest establishment of the latter, I have not at any moment even *appeared* to have forgotten the former.

I am, sir, with feelings of great respect,

Your obedient servant,

HENRY F. CAMPBELL.

NOTE CONCLUSORY.

In the foregoing pages, we are aware that we have advanced views which, if they meet general acceptation, must, to a certain degree, modify some of the established doctrines of the profession, not only with regard to pathology, but in physiology likewise. There is, perhaps, no one department of pathology in which so much valuable matter has been collected, in which such a treasury of facts has been laid up for data, as in the department of continued fevers. M. Louis, using these as the basis of his observations, added vastly to them, and gained an authority and command for his opinions, from which there was no appeal. The intestinal lesions of typhoid fever became to be regarded as the origin and the cause of all the phenomena presented by the disease—indeed, as the disease itself, and not, as we have endeavored to show, but one of its *manifestations*. The objections to his theory, and the grounds for regarding these intestinal lesions and all the other phenomena of typhoid fever as *common results* of aberrant nervous action in the ganglionic system, have been fully presented to the reader in the second paper of this volume. By pursuing a similar line of argument, *all* the various forms of those fevers which we have classed under the head of "Ganglionic Fevers," can be rationally traced to the same origin, *and they will all be found to derive every one of those manifestations which peculiarize them as a class, from the* SECRETORY SYSTEM OF NERVES. It is this one great fact which constitutes the common basis of their classification as found in the introduction to the present collection.

In relation to the discussion of the question of Priority in the matter of the Excito-Secretory System, Dr. Marshall Hall has generously yielded all that we claimed in regard to it; he says that it is undeniable that we first called attention to it, that we named it, and that the idea and designation belong to us; and, further, that the whole ample field of the application of the Excito-secretory action

to Pathology, is indisputably ours. That he should give to M. Bernard the credit of having first *demonstrated* it *experimentally* we do not object; our own conclusions were arrived at from the observation of the results of morbid action, years before, and we were fully satisfied in regard to the function, and announced it plainly, before any experiment had been made. In the following brief extracts from his letter to the *London Lancet* (May 2, 1857), will be found the substance of his adjudication of the question:—

"It would be unjust to deny that Dr. Campbell has the merit of having first called attention to the excito-secretory sub-system, in the year 1850, and that he imposed this very designation in 1853.

"So far Dr. Campbell's claims are undeniable, and I would say 'palmam qui meruit ferat.'

"I arrive at this conclusion: the *idea* and the *designation* of the excito-secretory action belong to Dr. Campbell, but his details are limited to pathology and observation. The elaborate *experimental demonstration* of reflex excito-secretory action is the result of the experimental labors of M. Claude Bernard. And *now* I say—'suum cuique.'

"My own claim is of a very different character, and I renounce every other. It consists in the vast *generalization* of the excito-secretory action throughout the system."

"There is, perhaps, not a point in the general cutaneous surface, in which tetanus—an excito-*motor* effect—may not originate; there is scarcely a point in which internal inflammation—an excito-*secretory* effect—may not be excited.

"*Every* point of the animal economy is in *solidarité* by a reflex excito-secretory action with every other!"

And he thus concludes his reply to our communication:—

"I trust Dr. Campbell will be satisfied with my adjudication. There is in the *excito-secretory* function, as applied to pathology, an ample field of inquiry for his life's career, and it is indisputably—HIS OWN. He first detected it, gave it its designation, and saw its vast importance.

I am, Sir, your obedient servant,

MARSHALL HALL.

April, 1857."

The relative value of *observation* and *experiment* being a prominent theme of one of the papers in the present collection, we forbear to remark further upon the subject in this place. Suffice it to say,

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that we considered the excito-secretory action sufficiently *demonstrated* from our *observations* long before M. Bernard ever made an experiment.

"——— With *thy* NAME this song begun—
——— With *thy* NAME thus much shall end."
Childe Harold's Pilgrimage.

The initial page of this volume opened with a grateful and an admiring dedication to Dr. Marshall Hall, and we had hoped long to enjoy the happiness of *his* encouragement and approval in our future labors—but this, by the inscrutable decree of Divine Wisdom, could not be—these closing lines must be saddened by the melancholy record of his death. The *London Lancet* of August 15, 1857, contains the following mournful intelligence:—

"Death, that most unsparing of tyrants, has exacted from the greatest physiologist of the age the last debt of nature. Slowly, surely, and relentlessly, disease has been undermining the earthly tabernacle of a mind which, for vast powers, high purposes, and indomitable energy, has found no superior in its native land in the present half-century. On Tuesday last, the 11th inst., Dr. Marshall Hall died at Brighton, aged 67 years."

We could easily have changed the wording of our dedication, on hearing of his departure, by communicating with the publishers—but we could not bear to make the alteration. Inscribed to Marshall Hall—the *living* Marshall Hall—*so now let it remain*—for, though he no more walks among the children of men—no longer solves for us, the abstruse problems of mysterious life, yet HIS—is one of those "immortal names" which will not—*can not* die. So far then from *changing* our dedication, we here ardently *reiterate* it, and again inscribe our humble labors, TO THE LIVING—EVER LIVING MARSHALL HALL!

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